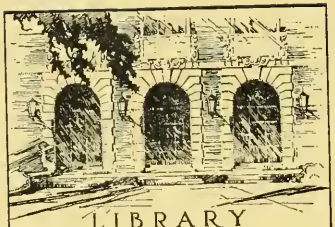

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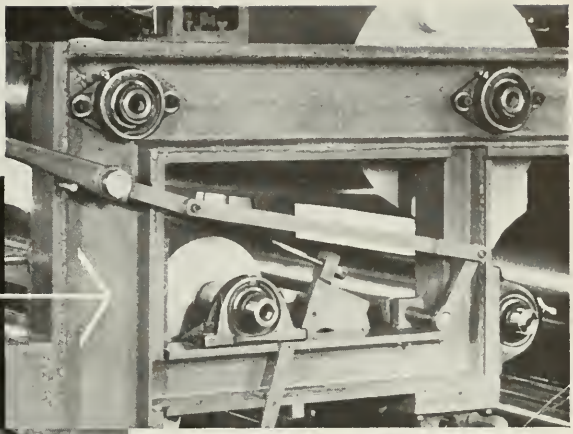

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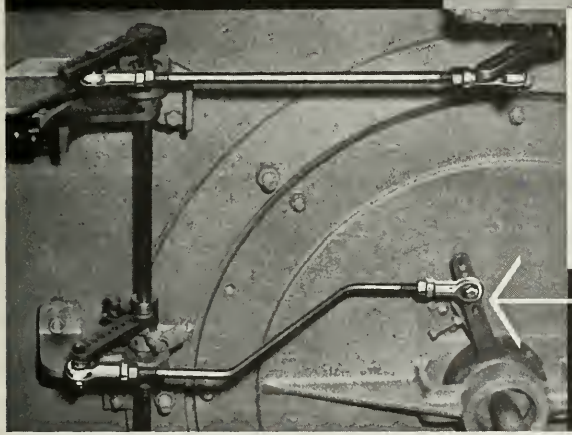

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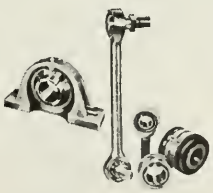

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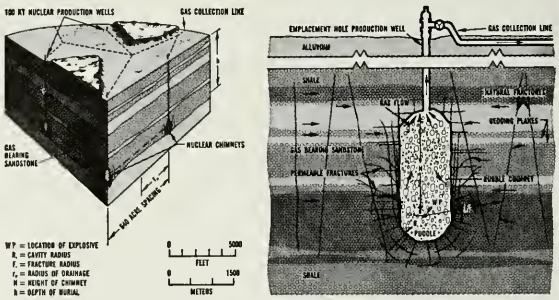

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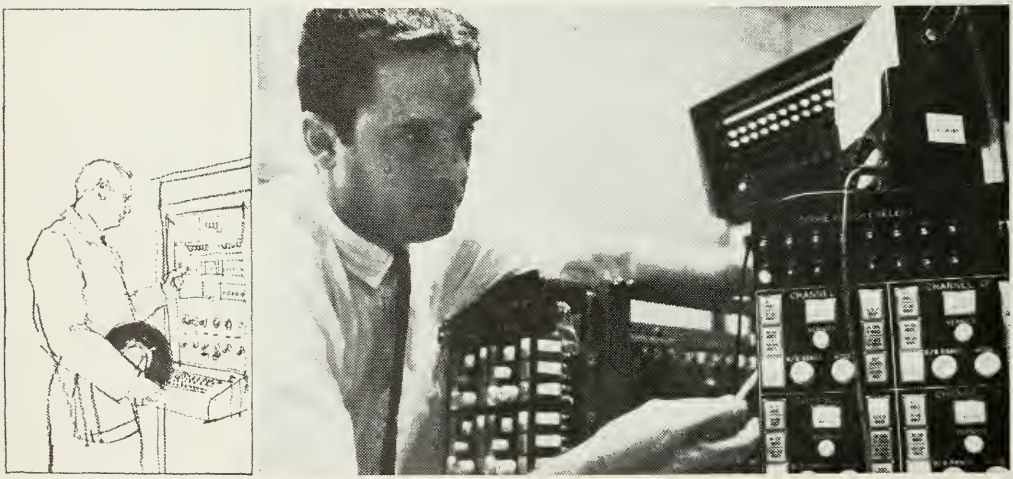

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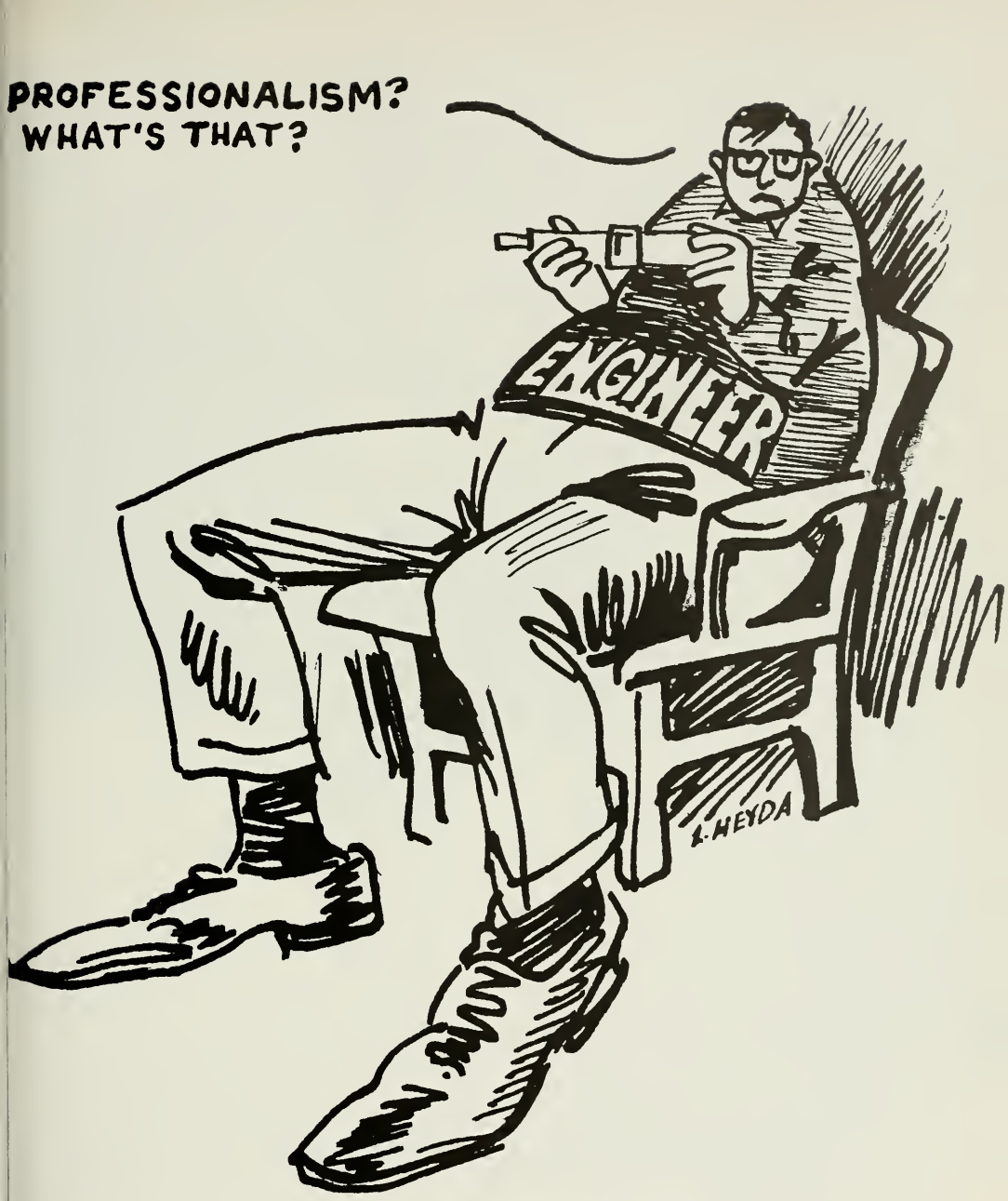
editorial

Are you preparing to be a professional Engineer? Few engineering students are. Today, with technology increasing at such a fantastic rate, those in management positions cannot have a thorough understanding of the applicability of new technical advances. It is becoming more and more difficult for them to optimally adapt these developments to society's needs. Consequently, the engineer is repeatedly being called upon by his associates in other professions for his opinions concerning the rates at which future technology should be expanded. Hence, a need develops for the engineer to be proficient not only in his ability to apply engineering skills but also in his ability to communicate and work effectively with both technically and non-technically minded people.

It is time more engineering students realized that their professional development must not be limited to academic achievement. It is equally important that the student engineer strive to improve his judgement, his leadership abilities, and above all, his skills of communication. One of the best places for the student to embark upon a program of non-academic professional development is within the activities of one of the many engineering societies on campus. No where else in the college does the average student have the opportunity to discuss informally with faculty members and representatives from industry the growing needs of engineers. Too often, many student engineers become so desperately involved in the race for grades that they ignore society's cry for engineers who can communicate and lead.

Remember that the successful engineers of the future must not only find the answers to tomorrow's problems but must be able to present their solutions in such a way that they will be appreciated and utilized.

Are you preparing to be a professional engineer?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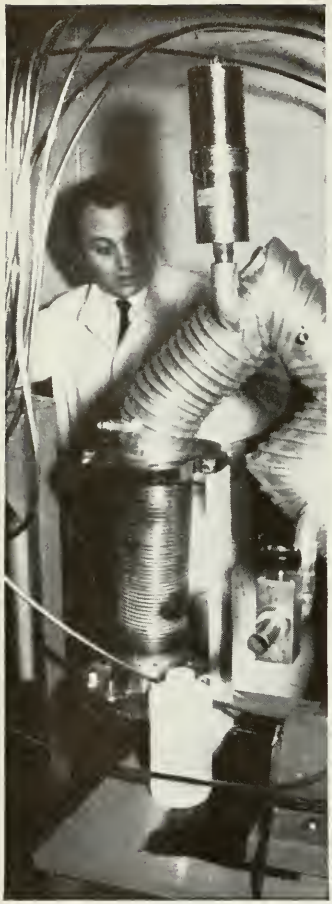

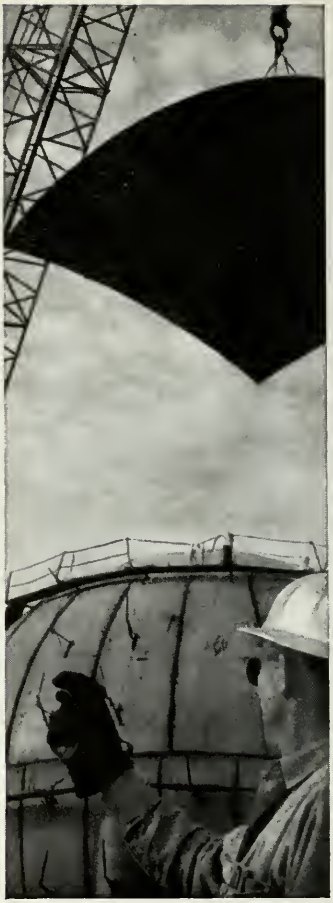

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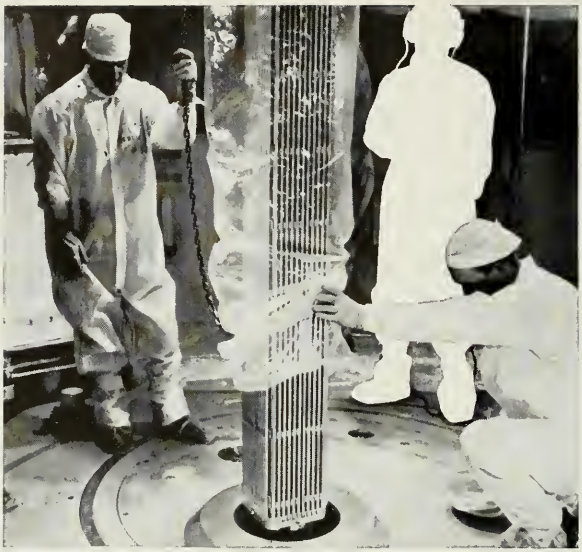

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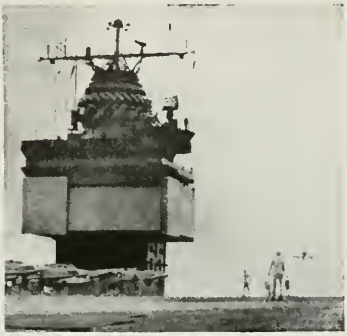

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"How to Gamble Without Really Gambling"

by Gary Kobliska

Game theory is a topic in mathematics about which comparatively little has been written. The basic aspects of game theory are relatively easy to understand, but difficulties arise rapidly if one goes too far afield. Bearing this in mind, we shall limit ourselves in this article to the solutions of somewhat simple two-person games. No rigorous approach to the subject will be given so that the reader can gain some background knowledge fairly easily.

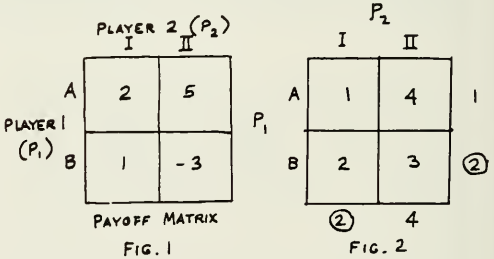
Gary Kobliska is a junior in Mathematics in the College of Liberal Arts and Sciences.

By "games" we mean not only those things which are usually considered "games," such as golf or Monopoly, but in general any conflict between two or more people in which they must make and carry out their decisions. In this broader sense, we will include such things as deciding who pays the luncheon check in a group of people, and whether or not to outbid your competitors at an auction. Two-person games are, as the name implies, games in which only two people participate, such as chess or tick-tack-toe. We shall also adopt the convention of considering Nature as a person and capable of making choices, such as whether or not it will rain on next April 21. We shall assume that each person will play rationally and will try to maximize their winnings and minimize their losses. Also, no player will be allowed to quit whenever he feels like doing so. In this way we are guaranteed to have an actual game to talk about, rather than a group of people doing nothing.

Each game has a finite but perhaps undetermined number of plays. A "play" consists of each person making a decision and the final result. For example, two players may each put up five dollars and then cut the cards to see who wins. If neither cheats, they have no influence upon the outcome. This action of cutting and examining the cards and pocketing the money will be considered a single play.

Now look at figure 1, the payoff matrix. This matrix sums up the amount of dollars or pesos or units of anything that Player 1 (P_1) receives from Player 2 (P_2). It also shows the strategies available to each player, namely A, B, I, and II. If P_1 plays strategy A, and if P_2 plays strategy I, then P_1 receives 2 units from his opponent. The numbers will always represent what P_1 wins, never what P_2 wins. Note the significance of a negative number: If P_1 plays B and P_2 plays II, then P_1 receives -3 units; i.e., P_1 pays P_2 3 units. Thus we can determine the value of any particular play. Note that since there are only two people involved (and no external considerations), we always know that whatever P_1 wins, P_2 must lose, and vice-versa, so that the total sum of all commodities is constant.

Figure 2 shows a different two-person game. We shall now determine a solution for this game; i.e., we shall determine in what proportion each player should use his two strategies. First, look at the strategies which P_1 can play. If P_1 decides upon A, the worst that he can do is to receive only one unit. We write the number "one" to the right of row A. Similarly, we write a "two" to the right of row B since the worst he can do there is to receive two units.



When we look at the possibilities open to P_2, we must remember that these positive numbers represent his losses rather than gains. Thus the worst he can do under strategies I and II is to lose two and four units respectively. Going back to P_1's strategies, we see that the better of these two choices is a gain of two units and therefore circle the number two. Likewise, the better of P_2's strategies is a loss of only two units, and this number is circled. Since the two circled numbers are equal, we immediately know that P_1

should always play B, and P_2 should always choose strategy I. This, of course, results in a win of two units for P_1. Because the two circled numbers are equal, the game is said to have a saddle point.

Why are these strategies the best? The answer is simple: If either player chooses his alternate strategy, he will be worse off than before. For instance, if P_1 suddenly switches to A, he now wins only one unit instead of two. Or, if P_2 changes strategies, he loses an extra unit. Readers who are famifiar with the idea of a saddle point in calculus may draw some comparisons between the two ideas.

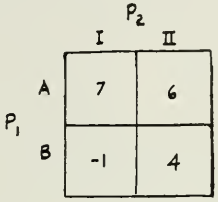


FIG. 3

As mentioned above, one property of a saddle point is that neither player should change strategies. For example, suppose that in the game of figure 3, strategies B and I are being played. Now since both players act rationally, it would immediately occur to P_1 that he could do better with strategy A than with B. So he makes the change accordingly and then receives seven units after each play. P_2 now realizes that he could do better with strategy II than with I, and he therefore switches to I. Now neither player wants to change his strategy since any change could only be harmful. It looks as if this game has a saddle point corresponding to strategies A and II. This fact may be verified by the first procedure given.

We have seen before what is meant by the value of a particular play. It is simply the amount which P1 gains after any one play in the game. This value may change as P_1 and P_2 change their strategies.

The value of the entire game, however, is a constant that is determined as soon as we are told in what proportions each strategy is played and the value of each play. By the value of the game, we mean the long-run mathematical expectation that P_1 has. Of course, this definition can be made more precise mathematically, but the present one will be sufficient for our purposes.

If every two-person game had a saddle point, we would merely have to find it in order to solve the game. But this is not the case. A quick check of the game in figure 4a will show that it has no saddle point. Now let's take the same game in figure 4b and try a different procedure. Since the game has no saddle point, it is evident that no single strategy will be sufficient for either player. Thus each player must play both his strategies in some fixed proportion.

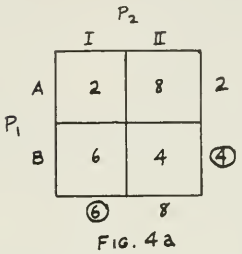


FIG. 4a

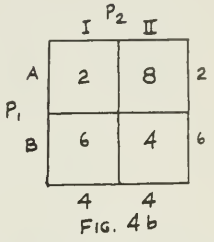


FIG. 4b

The derivation of the rule for finding this fixed proportion is beyond the scope of this article, but the rule is simple enough to be given here. First, look at strategy A and find the difference between the two possible values when P_2 plays I and II. Here, 8 - 2 = 6. Note that the positive difference is always taken. Write this number alongside the row for strategy B, not A. Next, subtract the two numbers of strategy B (6 - 4 = 2) and write this number after row A.

Repeat this procedure for the columns: Write 4 (6 - 2) at the bottom of column II, and write 4 (8 - 4) under column I. These numbers represent the proportions in which the strategies should be played. For example, P_1 should play strategies A and B in the ratio 2:6, or I:3, while P_2 would mix his strategies equally.

Now suppose that P_2 mixes his strategies equally but that P_1 plays A. Then P_2 would lose quantities amounting to two and eight units approximately equally; i.e., he would lose about five units on the average after each play. If P_1 decides to play B exclusively, then P_2 again loses five units on the average. Then it seems intuitively obvious that P_2 would lose about five units per play against any mixed strategy of P_1. This reasoning is correct, and the value of this game is 5.

Let figure 5 be any two-person two-strategy game which does not have a saddle point. Suppose that P_1 should play his strategies in the ratio w:x and P_2 in the ratio y:z as determined by the rule given before. Then the value of the game to PI can be shown to be

$$\frac{aw + cx}{w + x} = \frac{bw + dx}{w + x} = \frac{ay + bz}{y + z} = \frac{cy + dz}{y + z}.$$

To illustrate this, return to figure 4b, where a = 2, B = 8, c = 6, d = 4, w = 2, x = 6, y = 4, z = 4. Then the value of the game, as given by any one of the above four fractions, is indeed 5. If one player sticks to his best best strategy while the other adopts a different one, the value of the game is not changed. Thus it does not seem to be very important to adopt a strategy as long as your opponent knows what he is doing. This is actually the case in two-strategy games,

but in games where each player has three or more strategies, any deviation from the best mixture of strategies will usually result in unnecessary loss. Since the determination of correct strategies for three-strategy and higher games is somewhat more difficult, we shall not pursue the subject any further.

One of the most simple games to analyze would be that of matching pennies. Two players, each holding a coin, place them on a table. If the coins are both heads or both tails, P_1 wins P_2's penny. If they don't match, P_2 gets the coin. We assume that both players may decide whether to place their coins with heads or tails showing. How should P_1 play in order to win the most (or lose the least)?

Right away we think that since there is no distinction between heads and tails, they should both be played equally. After all, if P_1 plays heads more than half the time, an astutue P_2 would notice this and play accordingly. So it seems as though the strategies of heads (H) and tails (T) should be played in the same proportion. Now let's turn to game theory to see if we're right.

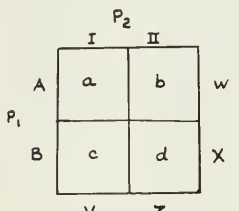


FIG. 5

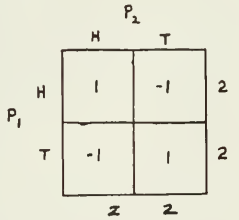


FIG. 6

Figure 6 shows the payoff matrix for the game of matching pennies. If P_1 and P_2 both play heads or both tails, the result is +1 for P_1. If they play oppositely, the value of the play is -1 for P_1. A quick check by either method shows that there are no saddle points, so we determine the proportions as before as 2:2 for both P_1 and P_2. Thus heads and tails should be played equally by both players, which is exactly what we expected. By using the formula given before with $a = 1$, $c = -1$, $w = 2$, $x = 2$, we see that the expectation for the game is 0; i.e., the game is fair to both players.

As the number of strategies or players increases, it becomes very much more difficult to determine the best combination of strategies for each player. Often, as in the case of chess or checkers, it is not even possible to list all the different possible plays. So chess players can go on playing chess without having to fear that someday a computer might completely analyze the game. Although at this stage game theory can easily analyze relatively simple situations which may occur in warfare or economics, chess will probably remain virtually untouched for years to come.

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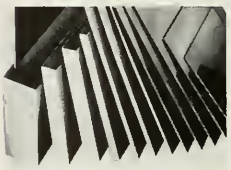
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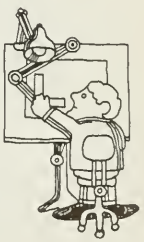

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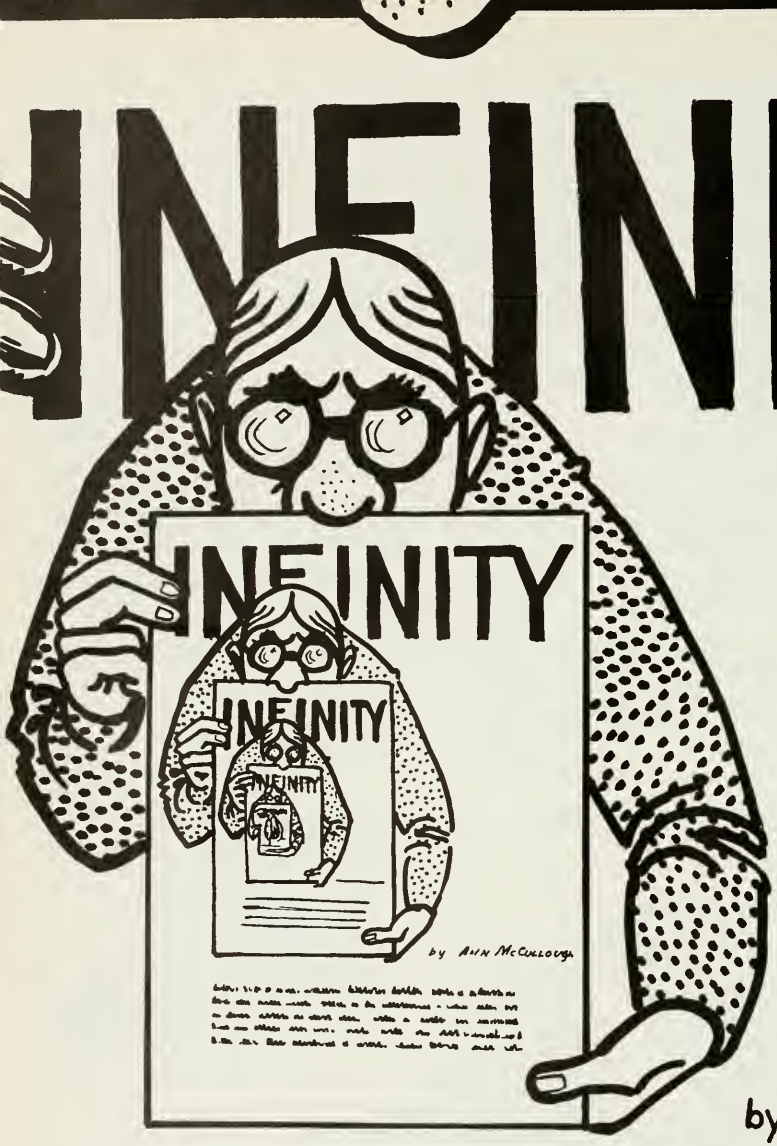
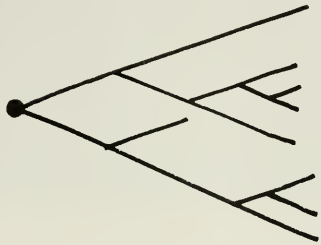


by Ann McCullough

We begin with a folk-saying, "There are always two possibilities." Since each choice made brings two new alternatives, it suggests this picture of infinity:



There are intimations of infinity designed especially for children. Japanese artisans make wooden dolls that open up and contain a similar doll, inside of which is another doll and so on through a sequence of five or six.

Poets have also employed the word in ways that are not far removed from mathematical aspects of infinity. Juliet's line about her love for Romeo, "the more I give to thee, the more I have," exaggerates a characteristic property of cardinal infinities. Blake's image, "to hold infinity in the palm of your hand and eternity in an hour," corresponds to the mathematical fact that a segment as short as the palm's lifeline has as many point on it as an infinitely long line.

Very instructive are the metaphysical arguments of Zeno directed to the conclusion that physical motion is impossible. He proposed four questions or paradoxes dealing with the concept then current that a line is composed of an infinite number of points. The first of Zeno's paradoxes stated that there can be no motion, for in order to transverse any distance whatever, it is necessary to reach the midpoint of that distance before reaching the end, and to do this, one must transverse half of the half-distance before reaching the midpoint, and so on, ad infinitum. It is said that one of his auditors tried to refute this point by walking across the lecture room to prove that motion does exist.

The second paradox is related to Achilles and the tortoise. Even though Achilles was able to run faster than the tortoise, if the tortoise were to start first, he would never be overtaken, for by the time that Achilles reached the spot A where the tortoise was a moment ago, the tortoise would be at B, a little further along. When Achilles reached B, the tortoise would be at C, and so on.

The third paradox showed that a moving object is always at rest, for at any instant it is in a fixed position, that is, it is at rest. Since this is true at every instant, it is true for all instants and the object never moves.

The fourth paradox stated that if the points on a line A were moving to the left and those on C to the right while those on B remained stationary, then in traversing any given distance a point C passes twice as many points in A as it does in B. In other words, a unit length of one line may have on it twice as many points as a unit length of another line.

The general bearing of these paradoxes, then, was that if a quantity is infinitely divisible its parts become zero, and the sum of these parts is zero also; for otherwise the individual parts have definite size and the sum of an infinite number of them is infinity.

Let us now turn to the mathematical conception. Aristotle, in keeping with his tenet that the unknowable exists only as a potentiality, refused to recognize a proper infinity (one that is actually realized or completed). Arguing that a body must have form and therefore must be bounded, he concluded that the bounded cannot be infinite. He distinguished between two kinds of potential infinities: one in arithmetic in the direction of successive addition (infinitely large) and one in geometry in the direction of successive division (infinitely small). In connection with the latter, he inveighed against those geometers of the time who upheld a doctrine in which a line segment is composed of infinitely many fixed infinitesimals or indivisibles. In spite of his denial of an infinitesimal in arithmetic, his reference to division by O is virtually equivalent to the consideration of the infinitely large; just as there can be no such thing as the ratio of a line segment to a point, Aristotle held, "there is no proportion between something and nothing." The quotient of an non-zero number divided by zero is infinite.

Whereas Greek logical rigor resulted in avoidance of specific reference to infinities in mathematics, the Hindus showed no such qualms. Thus it is that the earliest clear-cut reference to the infinite in Arithmetic occurs in the *Vija-Ganits:*

> Statement: divided 3, divisor 0, quotient 3/0. This fraction, of which the denominator is cipher, is termed an infinite quantity. In this quantity consisting of that which has cipher for its divisor, there is no alteration, although many be inserted or extracted; as no change takes place in the infinite and immutable God.

In many theologies, God has been conceived of as infinite in knowledge, power, and goodness; but the theological and metaphysical infinities are not clearly defined, and it has been argued that knowledge of the infinite is impossible. Nevertheless, the case for a proper infinity has been maintained by the recognition of the possibility of the existence of that which is not subject to the laws of reasoning and is not comprehensible to the mind.

The struggle between the logical mind (which saw contradictions in the conception of infinity) and the mystic tendency (which exempt the conception from the laws of ordered reasoning) was of particular interest to medieval scholastic philosophers. One of the contributions of the later Middle Ages to the problem was the

argument that infinity has its own laws, and that it is wrong to attribute to it properties that hold for finite quantities. Scholars of the 13th and 14th centuries recognized two kinds of infinity: a categorematic infinity, in which the infinite magnitude or quantity is actually realized, and a syncategorematic in which a quantity can be increased without limit. The apparent sophisms concerning infinity are resolvable if one recognizes that arguments with respect to infinity do not proceed as do those involving finite quantities. In particular, a finite part can have no ratio to an infinite whole, for otherwise the addition of a part to the whole would result in no change in magnitude.

The infinitude of the universe was argued by astronomers and theologians following the work of Copernicus. Of greater significance is the resolution of the nature of infinity made by Galileo. Every positive integer, he pointed out, has one and only one perfect square. Conversely, every perfect square is the square of one and only one positive integer. In a sense, then, there are just as many perfect squares as there are positive integers; yet, paradoxically, this would contradict the axiom that the whole is greater than any of its parts, inasmuch as not all of the positive integers are perfect squares, and the perfect squares form part of all the positive integers. Instead, he simply concluded that more than, equal to, and less than do not apply to infinite qualities.

Wallis, in arithmetizing, the method of indivisibles, for the first time introduced the modern symbol for infinity. Although this adds little to the understanding of the concept, the availability of a convenient notation encouraged mathematicians to use infinitely large and infinitely small with little critical interpretation.

A period of rigor that came in the 19th century achieved a relatively satisfactory solution by basing both the integral and the differential calculus upon the concept of a limit. The expression entering to integral and differential calculus seemed to require only the improperly infinitesimal and the improperly infinite. The variables are potentially infinitely small and they become less than any given quantity, or potentially large in that they become larger than any preassigned magnitude.

The differential calculus has postulated the existence of infinitely small magnitudes of varying orders — a first differential, a second differential, and so on indefinitely, but it was Augustin Couchy who rendered precise the concept of "order" of an infinitesimal. If: $\lim f(x) = 0$, then the function $f(x)$ is said to be infinitesimal with respect to x and if $\lim \frac{f(x)}{x} = k = 0$, the number n is called the order of the infinitesimal $f(x)$ with respect to x. An infinitesimal here is a dependent variable, and not a fixed quantity, and hence it is equivalent to what Aristotle designated as a quantity potentially infinitely small.

Bonanzo was fascinated by paradoxed that existed in the completed infinite. He called attention once to Galileo's paradoxes for infinite sets where a proper subset can be put into a 1:1 correspondence with the whole set. The set v of whole numbers between 0 and 12 can be paired with a subject x of real numbers 0 through five by the relation $12x = 5v$. For every x, there is a v, and for every y there is an x. No infinite set, he concluded, can have this property, whereas all finite sets enjoy it.

Dedekind defined an infinite aggregate as: a system S is said to be infinite when it is similar to a proper part of itself; in the contrary case, S is said to be a finite system.

Cantor went far beyond the definition of infinite sets and developed an arithmetic of transfinite numbers. Cantor noted his new arithmetic by the introduction of a new notation, abandoning entirely the old symbol. The set of all integers he designated by (aleph null). Aleph null is the smallest of all transfinite numbers. It has no immediate predecessor, inasmuch as the removal of one natural number from the set still leaves us with a set that can be made to correspond to the original. Nor do we get a new transfinite number simply by adding 1 to aleph null. One of the most striking results of Cantor's sets is the demonstration that there are transfinite numbers beyond aleph null. The set of all rational fractions can be put into a 1:1 correspondence with the positive integers, hence this set also has the transfinite number aleph null. The class of all algebraic numbers, likewise, can be put into a 1:1 correspondence with the positive integers, and it too is represented by aleph null. Cantor found, on the other hand, that the real numbers are so numerous that they constitute a set with a higher transfinite number "c", known as the number of the continuum. This is the number of the class of all points on a line or curve, or on a segment of a line or curve. He showed that points in an area however large can be matched against the points on a line segment, no matter how small and hence in these cases the transfinite number is still "c". Still larger than "c", nevertheless, is the set of all functional relationships, the transfinite number of which is denoted by "f".

It is known that there is no transfinite below aleph null. Thin out the rational numbers as one will — as by taking only every billionth natural number — the set still has the transfinite number aleph null. Whether there are transfinite numbers between aleph null and c, and "c" and "f", is not known. But aggregated of larger transfinite numbers can be created, and the process can be continued indefinitely. There is no "last" transfinite number.

The proper infinity, through Cantor, has been established in mathematics. But Cantor's theory of sets does not provide for an infinitesimal and modern quantum mechanics makes questionable the existence in nature of a proper infinitesimal. As stated by mathematicians however, no one will drive us out of the paradise created for us by Cantor.

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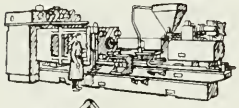

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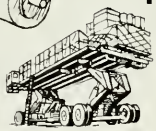

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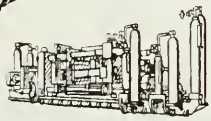

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The Sea

What about its Resources ?

by John Bourgoin

Considering the enormous sums of money spent on space research today, it seems unreasonable that we should have neglected a great unknown inner space much closer to us — the sea. There is fourteen times as much surface water as land above sea level. Scientists are looking to the sea as the only really hopeful solution to the ever increasing world problems of waste disposal, food, mineral resources, fuel, and, of course, water. Necessity is causing the nation to develop an increased awareness of the potential and urgentness of the development of the sea's resources. As the problem of finding fresh water becomes increasingly more serious, the most obvious solution is desalination of sea water. By 1980, our fresh water needs will double to 400 billion gallons per day. Even now New York City uses one billion gallons daily. Industry takes 270 tons of water to make one ton of steel and 4,700 tons of water to make but one ton of synthetic rubber. The sea is the only practical source of the enormous amounts of water that we will consume later in this century. Thus, economical desalination methods and equipment must be developed. Studies of the ocean surface and water currents reveal more about climates, and probes of the floor of the sea unlock the secrets of the continental evolution. From the study of marine life it is possible to gain a great deal of insight into the evolution and structure of other animals, including human beings. Yet until recently there was little organized work being done on studies of the sea. Advancing technology is solving many of the problems of deep sea research and thereby stimulating discoveries in all the diverse areas of marine science.

The science of the seas, oceanography, draws on several branches of science: geology, meterology, biology, chemistry, physics, geophysics, geochemistry, mechanics, and mathematics. It is an environmental science which attempts to chart the ocean floors including the rocks and sediments, to understand the interaction bebetween the sea and atmosphere, to study the behavior of its animals and organisms, and to explore the chemistry and physics of the sea water and sea floor. Because of the complex vertical and horizontal movements of the ocean waters, it is necessary to study all the oceans together as a single unit. Oceanic study unites these sciences because of the complex interactions of the physical, chemical, and biological aspects of the oceans.

John Bourgoin, a senior in Electrical Engineering, is an Honors student as well as the Copy Editor of the Technograph.

Some phases of oceanographic research can be carried out in the laboratory and the data room (as is done at the University of Illinois by Professor Adrian Richards' group). Obviously, though, man must go out to sea with vessels especially built for research to obtain samples. Such surveys and studies require extremely careful planning because of the high cost involved in outfitting a research ship. The ship must be 300 tons or more if it is to take data very far from the shore line. It must be equipped with adequate laboratories and deck space for preliminary analyses so that new discoveries will not be passed without obtaining additional information. Furthermore, it must have the machinery required for handling the complex and heavy data-taking equipment which is lowered to the ocean depths. Such equipment includes coring devices, echo sounders for depth measurement and plots of profiles of the ocean floor, heat probes for measuring the flow of heat from the earth's interior, hydrophotometers for measuring the light scattering in the water, and deep sea cameras. A large amount of positioning equipment is also required because of the accuracies required when charting an unknown region. Inertial guidance systems are now so accurate that a ship can determine its position to within about ten meters of its true position. Sounding devices can be used to give a good picture of the temperature strata within the ocean as well as the layers of earth beneath the ocean floor. Strata with different temperatures have different densities. These strata are often well defined, and the sound waves are partially reflected at the interface between the two strata. Thus, it is possible to map the temperature strata, and therefore the currents, from the surface. Seismic measurements of the

Built by Westinghouse, this large seawater plant and the adjacent electric power plant make the U. S. Naval Base at Guantanamo Bay, Cuba, completely self-sufficient for both its fresh water needs and its electrical power supply. The water conversion plant produces 2.2 million gallons a day of fresh water from the Caribbean Sea. (NAPS)

ocean subfloor use the same principle. Such measurements are usually carried out with the aid of two ships, one running on a fixed course and the other stationary. The moving ship drops explosive charges into the water while the second ship records the reflected or refracted sound waves. Another device which aids in seismic data taking is a very high energy acoustic probe. With this instrument, scientists can take soundings which give them information about the strata of rock below the sediment and water covers. Actual physical and chemical analyses of these strata are dependent upon the samples of the strata. These samples are obtained by inserting tubes directly into the ocean floor. The material that is brought back to the surface in these tubes is largely undisturbed. Using incremental techniques, oceanographers can take samples 100 meters or more into the sediment.

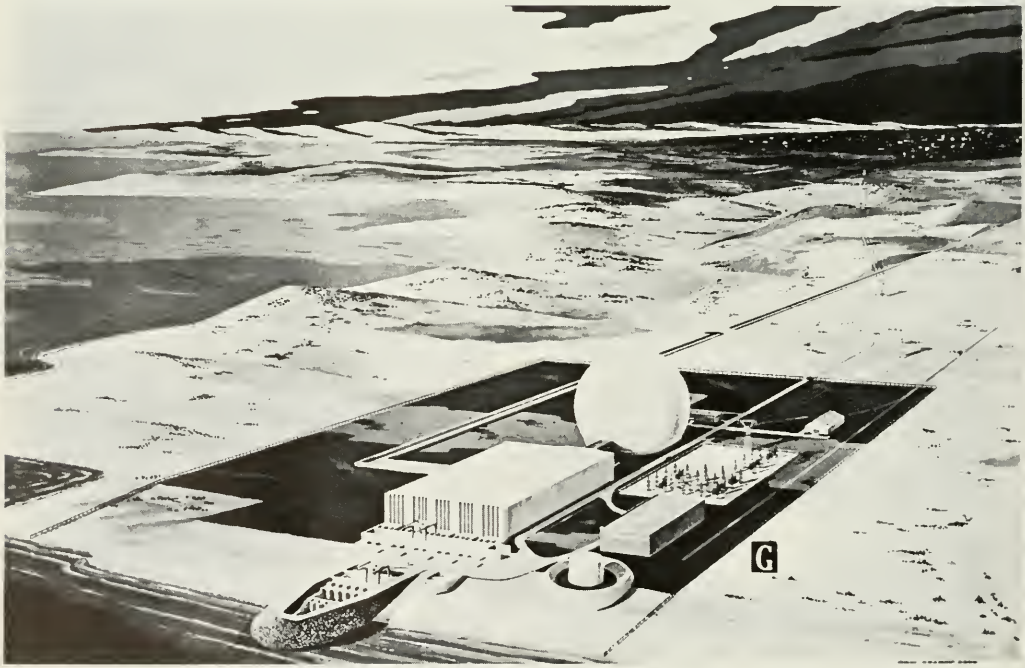
Man knows very little about the sea. Apart from the huge job of charting and mapping the ocean floor and currents, very little is known about deep sea currents and what causes them. Oceanographers know virtually nothing about the effect of tides in the deep sea. Another unexplored problem is that of the heat exchange between the sea and the sky, a determining factor in the weather and the ocean circulation.

It is interesting to note that the climate of the past million years or so can be studied with relative ease in the ocean. Using radioactive dating methods and geochemistry, scientists can determine climatological variations to a high degree of accuracy. Cores only 500 meters deep can reveal several million years of history. A core to the Mohorovicic Discontinuity (Moho), which is about three miles below the ocean floor, could reveal much information about the origin of

the earth.

The marine biologist has a great opportunity to study a wide variety of aspects of animal life. Communities of fauna, distribution of the species, and the zonation of animals on the shore and in the ocean are virtually untapped. The food resources of the sea are potentially greater than those of land because the oceans receive nearly three times as much life giving radiation from the sun (due to their relative surface area) as does the land. Plankton and other food organisms which fish feed upon abound. A knowledge of the currents which carry these organisms and the conditions under which fish thrive in the oceans should tell us much about finding more of the huge schools of fish that exist in the seas. A more thorough knowledge of the chemistry and environment will lead to cultivations of fish not totally unlike the keeping of animals on land. New and more efficient methods of catching fish will be devised. Some of the newer ways use sonar to spot schools of fish, chemical baits, and "fences" of air bubbles to trap the fish. The use of plankton directly as food must also be researched.

The oceans are a great source of energy and minerals. Sea water is virtually a limitless source of deuterium which powers the fusion reactions of the hydrogen bomb. Tidal energies have already been harnessed. There are many possible cycles for generating power from the movement of tides, but the most basic is the pure generation cycle. As the tides rise and fall, water is let in and out of a very large reservoir. At high tide, the reservoir is full. As the tide begins to fall, water is let out of the reservoir through turbines which drive generators. When the reservoir level has fallen to a level too low to maintain turbine horsepower, the generation stops. As the tides begin to rise, the blades on the turbine wheels are reversed and water flows through the turbines again this time into the reservoir until the high level is once again reached. The obvious disadvantage is the long time lag between tides during which no power is being generated. Pumping — generating cycles have been worked out which counteract this difficulty. Although they exist in far too dilute amounts to extract economically at present, the minerals found in the oceans' three hundred million cubic miles



This is the Oak Ridge National Laboratory concept of a dual-purpose plant for desalting water and producing electricity. The large, rectangular building would house a multistage flash evaporator capable of producing 250 million gallons per day of fresh water from the sea, according to Anaconda American Brass Company. The sphere is the nuclear powerhouse in which a reactor produces steam to heat the seawater and to generate electricity.

Fresh water from salt... one artist's solution!

(Drawing courtesy Anaconda American Brass)

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of water represent a fantastic source which may be tapped when those on land become depleted or when methods are devised to extract them economically.

Perhaps the most pressing problem that the oceans can solve is that of water shortage. The human body can tolerate only a maximum of a two per-cent saline solution. The average saltiness of the oceans is three and one-half per-cent. Throughout the ages the problems of desalting ocean water were problems of cost. However, with the pressing needs for efficient methods of desalination, technology has reached the stage where economical fresh water from the sea is possible. Plants in operation now are turning out fresh water for around one dollar per thousand gallons. Industry leaders believe that they could build desalting plants from fifty to one-hundred fifty million million gallons per day capacity that would produce fresh water in the thirty to forty cent range. The long range goal is twenty-cent water. As a comparison, the average cost of purified fresh water, delivered, in U. S. communities today is forty-two cents per thousand gallons, although figures vary considerably from city to city.

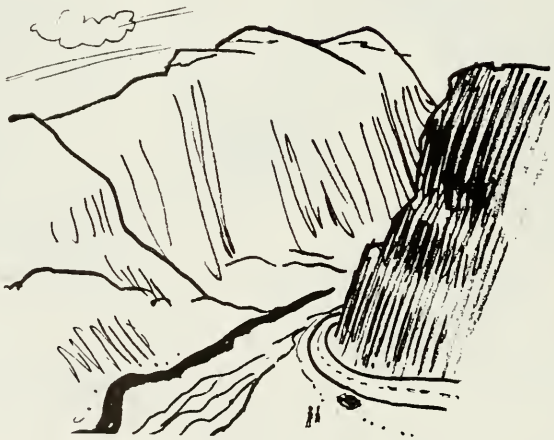
The chief method of desalination is distillation. Distillation is recorded in history as far back as Aristotle. However, only recently has it been used on the large scales needed for fresh water in cities. The market for desalination plants has grown tremendously in the past two decades. Government appropriations for the research of desalination techniques have skyrocketed.

In the big desalination plants now operating or in the planning stages, the chief method of desalination, multi-stage flash distillation, is an adaptation of the basic principle of distillation. Here's how it works:

Seawater is heated and fed into a chamber where the pressure is lowered. A portion of the water "flashes" into vapor which is condensed on the outer surface of the heat exchanger tubes. The resulting condensate is suitable for potable or industrial water. The process is repeated through many stages at decreasing pressures, to provide a large volume of desalted water.

One of the drawbacks of the present desalination plants is the enormous amounts of metal required for condenser tubing. For example, Anaconda American Brass Company, a major supplier of copper alloy condenser tubes for desalination plants, estimates that for one particular plant under design, a total of thirty million pounds of copper-nickel tubes will be required. That amounts to about 18,000 miles of tubing. Thus, the search for better methods is essential if sea water is to be desalted on the huge scales required for supplying the needs of future populations and industries. The old saying "Water, water everywhere, but not a drop to drink" may soon be obsolete.

Oceanographic research and development shows promise of tremendous growth during the next few years and is a field worthy of consideration for study.



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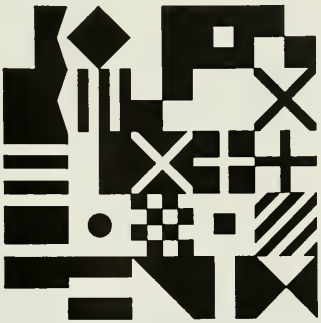

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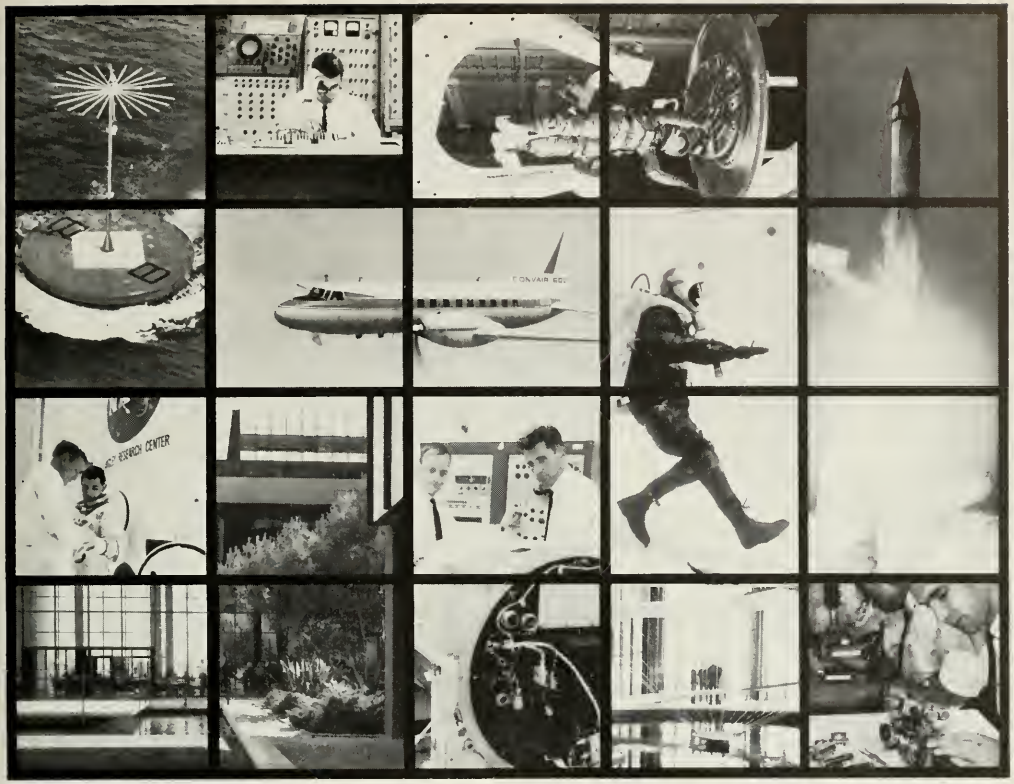

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SUMMER JOBS – Why Start Now?

by Tom Brown

An article concerning summer jobs published in the middle of the fall may seem like *Technograph*'s first six-month late article; but before believing this tempting thought, consider that this article concerns the summer of 1968. For summer technical jobs now seem more plentiful than ever, and the opportunity for students to significantly advance themselves through summer employment has never been greater.

Tom Brown, a senior in Civil Engineering, is currently the Managing Editor of the Technograph.

The advantages of summer work for the student are many. Of course, every student can use the money he makes during a summer's work. These jobs also provide the opportunity for students to make contacts concerning permanent employment. Not only does a summer job provide experience in applying formal course work, but it can also make following courses much more interesting. A summer job may even be a major factor in a student's decision about his post graduation plans. Thus as Prof. J. O. Kopplin, Chairman of the Engineering Honors Council, says, "Summer employment is a very valuable part of the student engineer's education."

Traditionally, employers have offered summer jobs for the purpose of recruiting and analyzing prospective employees. Also, offering summer work has not hurt the public relations of many concerns. About four years ago, according to Mrs. Pauline Chapman, Director of the College of Engineering Placement Office, a major upswing in the number of summer technical jobs began. Mrs. Chapman cites two major recruiting-oriented reasons for this surge. First, the demand for graduate engineers is far exceeding the supply. Employers of engineers feel they must make their names known to the graduate engineer. The second reason is summer employment began appearing more and more on the lists of reasons for accepting permanent positions. In the Placement Office's 1967 graduate report, "worked summer for company" appeared as the sixth most common reason for accepting a position. Responsibility, draft deferment, and benefits are among the twenty-six reasons listed as less common.

Although the College of Engineering can help a student acquire a summer job, the task of finding this employment ultimately lies with the student. The placement Office has summer application forms available for many companies and government agencies. However, Mrs. Chapman emphasizes that many employers would rather receive a personal letter of inquiry about summer employment than a standard placement form. The personal letter indicates student initiative, a very important quality to many employers. Prof. Kopplin points out that advisers will usually write recommendations for their students. Especially sophomores, with few technical courses, should seek their adviser's counsel about summer employment. He also emphasized that the initiative belongs to the student, that is employers want inquiries from students first and then recommendations from advisers.

The range of summer jobs available is about as wide as it is indefinite. Mrs. Chapman indicates that most companies do not have real sophisticated programs because the number of summer employees is usually determined only after the yearly budget is determined. Therefore, no general deadline for applications exists. Deadline dates range from fall to early summer, and it remains to the individual student's initiative to obtain information about particular employers. One generalization that can be made is that government jobs should be applied for early because security clearance is often needed.

Summer jobs also range in their degree of challenge and interest. Early thought about the type of work desired and inquiry into this type of work has led to

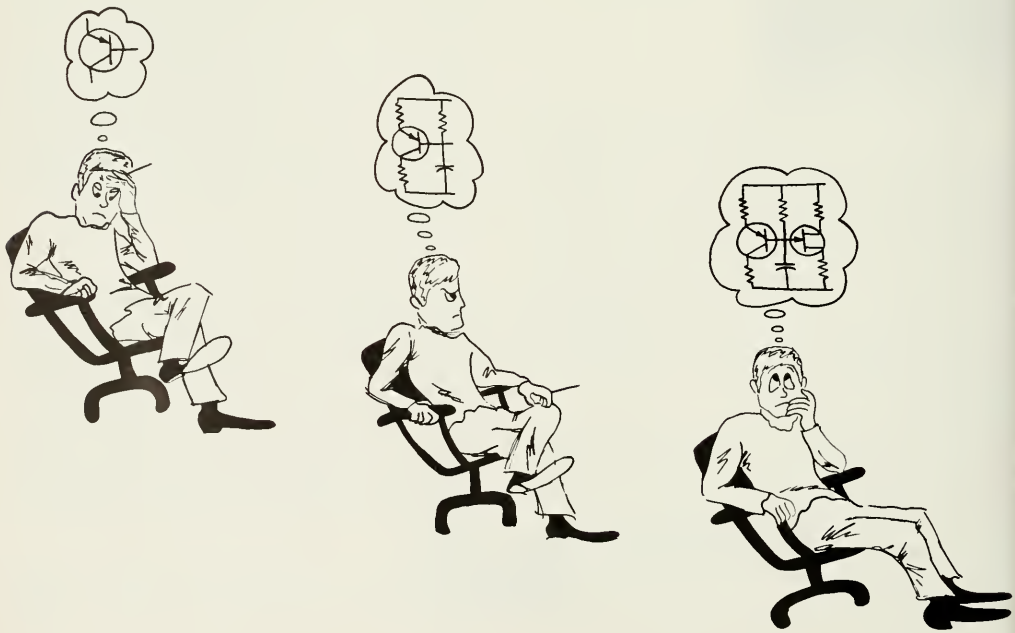
interesting summers for engineering students. The following comments were made by Jon Whittaker, senior in civil engineering. Jon search for and found a job in the field he is interested in, and the result was a very satisfying summer.

> ...this program is to allow the future college graduate an opportunity to get a "good look" at the company, and at the same time, allow the company to evaluate the student's potential and determine whether his interests and capabilities will benefit the company. Assignment of a challenging and well planned project, guidance and evaluation from a trained and competent supervisor, and establishment of goals and responsibilities were several "tools" used to judge my performance.
>
> I consider the opportunity afforded me an excellent one. The experience I gained in the understanding of the business world was beneficial, the evaluation by a trained supervisor of my abilities and strengths was invaluable, and the successful completion of a very necessary and challenging job was rewarding.

Special opportunities are available to students wishing to participate in the IAESTE (International Association for the Exchange of Students for Technical Experience) program. This program offers students the opportunity to broaden their cultural background by working with pay in a foreign country for an eight to twelve week summer period. Although students should expect total costs, including transportation, traveling, and living expenses to exceed their wages, this experience has proven invaluable to those who have taken part. This issue of *Technograph* contains an article by Madison Post, senior in Electrical Engineering and Math, concerning his experience in the IAESTE program. His article reveals the enthusiasm this experience evokes. Students may obtain more information about this program in the Associate Dean's office, 101 Engineering Hall.

Another possibility for summer experience is undergraduate research within the College of Engineering. Presently the National Science Foundation sponsors undergraduate research projects in two departments, civil enginering and chemical engineering. Mike Leifer, senior in civil engineering, relates details about this program in an article also in this issue of *Technograph*. The College of Agriculture also has sponsored a summer research program with projects concerning any application of science to agriculture. Engineering students are eligible to and have participated in this program. Prof. J. R. Lodge is the chairman of this program and additional information may be obtained from him.

Thus, the sources of summer opportunities for student engineers are plentiful, and all that is needed to tap these sources is a little initiative. Some thought and inquiries can lead to a summer of enjoyment and satisfaction. If the memory of a boring and unenjoyable summer job is still fresh, start thinking now about making next summer's work a satisfying and profitable experience.



Summer Job in Germany

by Madison Post

"International Association for the Exchange of Students for Technical Experience" sounds pretty dry, I know. One year ago I filled out a one-page questionnaire requesting a job in Germany, Switzerland, or England for the upcoming summer. I didn't expect much to happen. Today I can say I owe *IAESTE* the best three months of my life.

Anyone with technical background can apply just as I did, and he will have a 70% or better chance of being accepted into the *IAESTE* program. My summer's experience is a fine illustration of what *IAESTE* has to offer.

The job offered to me was better than any I had heard of in the States. As a would-be senior in E.E. and Math I wanted summer employment that coincided with my interests in school, that would give me an insight into what industry was doing in my field, and (naturally) that paid well. *IAESTE* took my requests to the exchange table in New York. Here, jobs offered to foreign trainees by American firms are exchanged for jobs offered U. S. students by foreign industry. I was offered a position by Blaupunkt Radio, the largest European manufacturer of automobile radios, at their location in Hildesheim, Germany. The job paid DM 3.50 per hour, which converts to about 90¢ per hour, but is equivalent to earning $2.00 per hour because of the lower German standard of living. I was given seven days to accept or decline. After an exchange of letters with Blaupunkt in which they explained more specifically the position offered, and I expressed my desires more in detail, I found myself with a job as a technician-trainee in "Entwicklung Farbfernsehen" (developmental color television), exactly the type of thing I wanted to do. A three week vacation in the middle of the summer for private traveling and sightseeing was part of the package. Blaupunkt, as do many European firms, closed down for three weeks to give everyone a vacation at once, however jobs were still available during the vacation. *IAESTE*, in conjunction with the German *ASTA*, later arranged also for a seven-day tour of Berlin for all foreign trainees in Germany for only $15. Other trainees from the States whom I met on the plane going over had similar luck in getting jobs, although some accepted offers in fields different than their major because the countries they requested did not offer employment in their fields.

IAESTE chartered two 727 jets for each flight, over and back, and asked only $265 for the round trip second class — cheaper than student flights! One flew the New York-Amsterdam circuit, the other the New York-Brussels route. It was not required to take the chartered flight, but nearly everyone did.

Blaupunkt arranged for my room but I had to provide meals. Rent cost $22 a month for a room with a

family two miles from the factory. I purchased a large hot meal at noon from Blaupunkt for $1.50 per week and prepared my other meals cold at home.

The experience of working for Blaupunkt was too good to be true. The factory itself is located in the beautiful Hildesheimer Forest. No one from America would recognize it as a factory in that setting. I built test equipment which researchers designed, aligned and measured experimental circuits, and had free time to study, prod around, and ask questions of the engineers, who were all about. Before arriving in Hildesheim I was extremely afraid of the technical language barrier which I was positive existed. Actually most technical words are similar in all languages. People I worked with were well-educated and knew English, also a crutch I saved for emergencies. At the end of the traineeship I could read easily most technical books and could communicate intelligibly with my friends. All the latest test equipment was also available — most of it American. I not only learned a great deal about European color television but acquired practical knowledge through circuit construction and grew to deeply appreciate the German frame of mind. My ability to speak the language, of necessity, increased greatly. My job was not only enjoyable and well-paying but it was immensely valuable in terms of education — an education one cannot get in school.

During my vacation I met a group of Marquette University students studying in Hildesheim. We took a twelve-day tour of South Germany, France, Switzerland, and Austria — a never to be forgotten trip. Several of us also went to the Nürburg Ring for the German Grand Prix. Americans, both tourists and servicemen, were there in great numbers.

It is not at all difficult to be a trainee with *IAESTE*, and I heartily encourage anyone and everyone with technical background to apply. Not only do European countries participate in this international exchange but nations in the Near East, Africa, South Pacific, and Asia also exchange trainees. A registration fee of $35 is required, $20 of which is refunded if the student is not placed. Insurance for the summer costs $12 and a person must be properly immunized. It is best to have a working knowledge of the language of the country applied for but the requirement may be waived. Forms for application are available from:

IAESTE/US
866 United Nations Plaza
New York, N. Y. 10017

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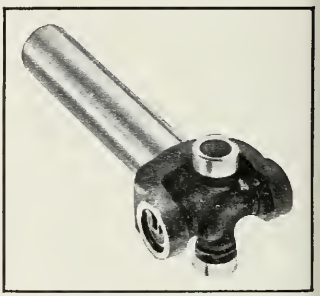
Yield strength represents the point at which materials exceed the elastic limit. Fatigue strength is the greatest stress which can be sustained when the load is applied repeatedly. As indicated by the table below, Malleable has an advantage over steel in fatigue strength and yield strength when grades of identical tensile strength are compared.

	TENSILE	YIELD	FATIGUE
1020 Steel	75,000 PSI	48,000 PSI	34,000 PSI
50007 Pearlitic Malleable Iron	75,000 PSI	50,000 PSI	37,000 PSI

Strength and Cost — Malleable iron has been described as providing more strengh per dollar than any other metal. There are many factors which contribute to this reputation. Malleable can be cast close to finish shape, thereby reducing or eliminating machining operations. What machining must be done can be accomplished quickly because Malleable iron is the most easily machined of all ferrous metals of comparable hardness.



This is a pearlitic Malleable iron universal joint yoke for an automobile. Subjected to repeated torque as the car reverses, speeds up and slows down, these high strength parts have an enviable record for reliability and service. One automaker reports no warranty claims on this part for the past seven years!

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Dr. Arnold M. Small, Director, Scientific Education, Hughes Aircraft Company, P.O. Box 90515, Los Angeles, Calif. 90009.

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GPA is _____ out of possible _____

Also have (or expect) Masters degree in _____ (Field)

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from _____ (Institution)

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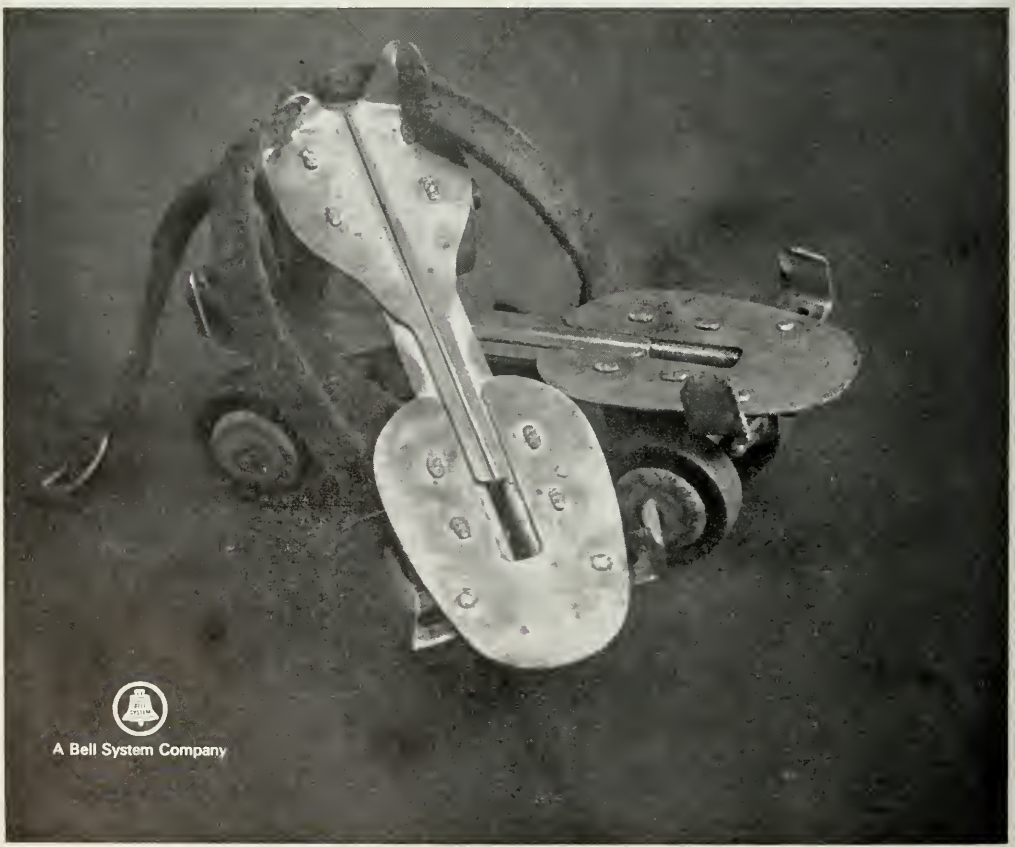

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METALS —Aluminum —Brass —Ormet, Corp.	Burnside, La Chattanooga, Tenn. Gulfport, Miss. Hannibal, Ohio East Alton, Ill. New Haven, Conn. Sedalia, Mo.	Alumina Aluminum Aluminum Extrusions Aluminum Sheet, Plate, Coils Brass Fabricated Parts Sheet & Strip — Brass Roll Bond Wire & Cable	ChE IE ME Metallurgy Met. Engineering Accounting Business Adm. Ind. Tech. Ind. Mgmt.	Manufacturing Production Sales Maintenance Finance Metals R&D
FOREST PRODS, PAPER & FILM —Olinkraft, Inc. —Ecusta —Film	West Monroe, La. Pisgah Forest, N.C. Covington, Indiana	Carbonizing Paper Fine Printing Papers Specialty Paper Products Cigarette Paper & Filters Cellophane Kraft Bags Kraft Paper Kraftboard Cartons Corrugated Containers Olinkraft Lumber	ChE Chemistry Pulp & Paper Tech. IE ME Mathematics Business Adm. Accounting	Marketing Process Engineering Plant Engineering Research & Dev. Statistician Systems Engineering Production Management General IE Design and Development Accounting
WINCHESTER-WESTERN	East Alton, Ill. New Haven, Conn. Marion, Ill. Kingsbury, Ind.	Sporting Arms Ammunition Powder Actuated tools Smokeless Ball Powders Solid Propellants Safety Flares Franchised Clubs	Ind. Tech. IE ME Mathematics ChE Accounting Business Adm. Marketing Personnel Mgt. Physics Ind. Mgmt.	Production Control Purchasing Manufacturing Plant Engineering Sales Financial Analysis Personnel Marketing R&D

If you find this chart interesting,

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For additional information about Olin, please contact your Placement Office or write Mr. Monte H. Jacoby, College Relations Officer, Olin, 460 Park Avenue, New York, N.Y. 10022. Olin is a Plan for Progress company and an equal opportunity employer (M & F).

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Union Carbide has developed silicone for an amazing range of products and purposes.

Examples: add silicones to paints and they become easier to apply; cover surfaces evenly, uniformly. Put them in spray-on starch and irons won't stick to cloth. Coat ovens with them and grease wipes off easily. Used on leather, shoes become water-repellent. Added to polishes, they give cars and furniture a quick, long-lasting shine.

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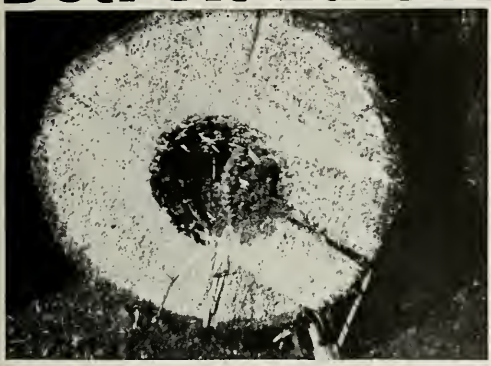
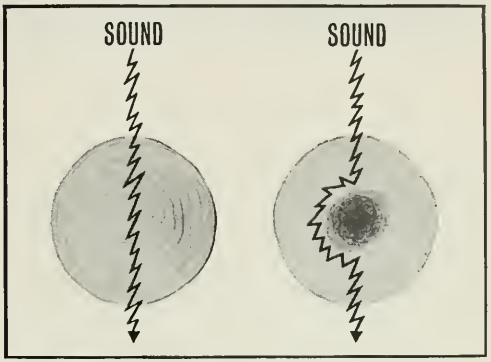


1. Edison engineer, Dick Popeck, wanted to find a more effective method of determining the amount of pole decay.



2. Dick's idea: Measure the time required for sound to travel through a pole. Sound takes longer to traverse a decayed pole.

3. Transistorized circuitry was designed. And a Sonic Pole Tester was built and tested.

4. Ed Hines, Director of Research, (left) discusses patent coverage with inventor Dick Popeck.

New ideas grow at Detroit Edison. The picture story here shows the progress of one, from its conception through its development, to finalization.

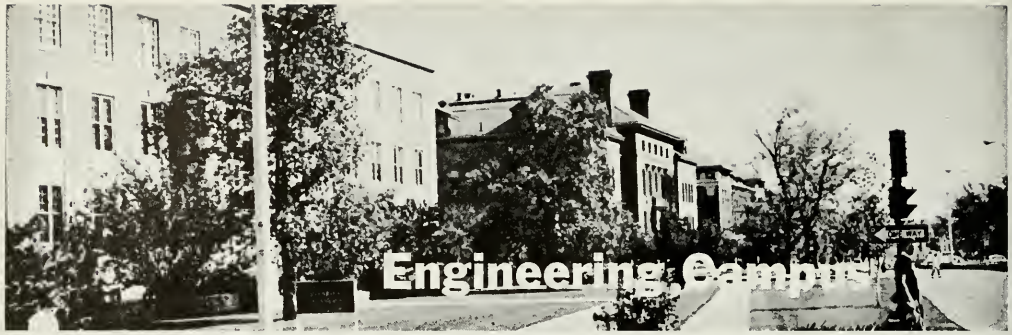
The development of the sonic pole testing device* has benefited the company and the young inventor both economically and professionally. The device helps Detroit Edison serve the electric industry's customers better and more economically.

Uses for the sonic pole tester range from the examination of wooden railroad bridges to the determination of the soundness of standing timber.

Detroit Edison's forward looking management . . . its engineering and research facilities . . . along with its liberal patent policy . . . make it an ideal place for the young man with ideas.

If you are interested in putting your ideas and energies to work—write to George Sold, The Detroit Edison Company, 2000 Second Avenue, Detroit, Michigan 48226, or visit the Edison representative when he interviews on campus. *U.S. Patent Applied for

DETROIT EDISON



THE INVALUABLE EXPERIENCE OF NSF UNDERGRADUATE RESEARCH

Does the idea of doing research work as an undergraduate awe or frighten you? It surely frightened me when the opportunity arose. After a full summer of work under a National Science Foundation Undergraduate Research grant, however, I am able now to speak, student to student, of the wealth of opportunities and experiences available under this program. If you are interested at all after reading this report, and if you will just exert enough effort to call Dr. R. N. Wright for further information, you may find an opening for yourself. NSF opportunities exist in the civil engineering and chemical engineering departments.

Participating in the NSF research project means a student is on his own; he picks his own project and he does it his own way. One selects a professor with related interests as an adviser, and for the first few weeks (or even months!) this adviser may be the only encouragement the student has. It is important to realize from the start that everyone is aware that students are new to research, and the first lessons come hard on how to handle it. It is equally important to know that sometime some light will break through, and from then on the student's own excitement and enthusiasm will help him progress.

Two regular semesters and one twelve week summer session are used to complete the work. Of course, the two regular semesters are used for background reading, getting organized, and writing a report. Most of the actual work is done in the summer session when students can devote full time to their projects. Approximately ten hours a week are expected of students the other two semesters. One should not let the time required bother him, though. If little time is put in at the beginning, one will find himself making up for it later when his interest has really been kindled.

The monetary rewards are substantial also. Students receive $150 each semester and $1200 for the twelve week summer session. This pay compares favorably with many engineering jobs in this area, especially when one realizes that every penny of the $1500 is tax free! Also, students receive course credit ranging from three to nine hours, depending on how well they do.

There are side benefits which I personally feel are as valuable as the above. If one wants to continue for a Master's Degree, he has a project which is already organized and which can be extended toward his Master's thesis. An NSF project also looks good on applications, either for graduate school or for a job. One will come to know personally many professors in his field, and this can be valuable now or later since these professors may write recommendations on his behalf. One meets all kinds of people through his work, ranging from other students and non-academic employees to professional men. These people, too, can be of valuable service and interesting to know.

Last, but not least, these projects can be fun and immensely self-satisfying. A student may not achieve the goals he originally aimed for, but the experiences gained are invaluable. The only way to know what I am trying to convey is to look into the opportunities yourself and give it a try. If you are interested, see or call Dr. R. N. Wright, 3213 Civil Engineering Building, 333-1328, or see your own adviser. I do hope some of you will try!

U OF I RANKS HIGH IN DEGREES

The University of Illinois ranks second in the nation in the number of Bachelor's Degrees conferred in engineering, third in total engineering degrees, and ninth in Masters Degrees, according to a report by the United States Office of Education covering 160 schools conferring 51,795 engineering degrees for the academic year of 1965-66. The top five schools were:

Purdue	*1,477*
MIT	*1,283*
Illinois	*1,177*
Berkeley	*1,089*
Michigan	*1,074*

Engineering Bachelor's Degrees totaled 35,815, and the top five schools were:

Purdue	*945*
Illinois	*754*
Michigan	*615*
Newark	*603*
Penn. State	*578*

Doctor's Degrees in engineering totaled 2,303, and the top schools were:

MIT	*173*
Illinois	*114*
Berkeley	*114*
Stanford	*106*
Purdue	*95*
Michigan	*74*

National total for engineering Master's Degrees was 13,677, and the top schools were:

MIT	*676*	*NYU*	*420*
Southern California	*509*	*Michigan*	*385*
Stanford	*508*	*Cornell*	*336*
Berkeley	*466*	*Illinois*	*309*
Purdue	*437*		

Though a total of 101,467 degrees granted is impressive, and an even greater number of degrees was granted last year, there is still a shortage of engineers in industry. A direct result of this shortage is the steady rise in salaries for starting engineers, now at $723 a month, up from $688 for last year at this time.

The lure of high paying jobs has taken its toll of potential graduate students. The percentage of students continuing their education beyond the bachelor's level is down from last year, as shown in a report for 1967 by Mrs. Pauline V. Chapman, college placement director. Last year the percentage was 30%; in 1964 40% of the graduates pursued higher degrees. This year the percentage was a low 27%.

TO ALL INTERESTED ENGINEERING STUDENTS:

'IVIL ENGINEERING DEDICATION *CONFERENCE*

The Department of Civil Engineering invites you to attend their Dedication Conference on November 9-10. The conference program will include the following sessions and events with the theme *A Look Ahead into the Next Century of Civil Engineering Education and Practice.*

NOVEMBER 9 (Thursday): *Rock Mechanics Session; Alumni Luncheon* (All are welcome); *Water Resources Session;* and the evening *Dedication Dinner* with Dr. Laurits Bjerrum as the guest speaker.

NOVEMBER 10 (Friday): *Systems Engineering Session;* Dedication of the new Civil Engineering Building at 11:30 A. M. with Governor Otto Kerner officiating; *Dedication Luncheon;* and Tours and Exhibits in the new building.

Information as to the technical sessions and meal events you plan to attend is needed. Ladies are welcome and their reservations are also desired. Please send your reservations or requests for further information to:

PROFESSOR ELLIS DANNER
205 Engineering Hall
University of Illinois
Urbana, Illinois 61801

indicating which technical sessions and which meal events you will attend.

SYMBOL DEPLETION

We've almost lost a good word, and we hate to see it go.

The movie industry may feel the same way about words such as colossal, gigantic, sensational and history-making. They're good words – good symbols. But they've been overused, and we tend to pay them little heed. Their effectiveness as symbols is being depleted.

One of our own problems is with the word "opportunity." It's suffering symbol depletion, too. It's passed over with scant notice in an advertisement. It's been used too much and too loosely.

This bothers us because we still like to talk about opportunity. A position at Collins holds great potential. Potential for involvement in designing and producing some of the most important communication systems in the world. Potential for progressive advancement in responsibility and income. Unsurpassed potential for pride-in-product.

That's opportunity.

And we wish we could use the word more often.

Collins representatives will visit your campus this year. Contact your College Placement Office for details.

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Bangkok • Frankfurt • Hong Kong • Kuala Lumpur • Los Angeles • London • Melbourne • Mexico City • New York • Paris • Rome • Washington • Wellington

Can there be this kind of excitement in engineering?

A high-performance car in a four-wheel drift around the first turn at Watkins Glen* typifies the excitement of sportscar racing . . . precision machinery and human skill in cool coordination.

Is it an exaggeration to suggest there should be an analogous excitement in your engineering career? In engineering, too, professional skill is constantly pitted against variables of mathematics, materials and men. And the pace can be fast.

This is the kind of engineering excitement Xerox can offer you:

- a strong drive into new areas and new technologies in a variety of fields . . . imaging, data handling, graphic arts, education
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To the Editor:

In the April issue of the *Technograph*, Joe Templin wrote that he felt G. E. 104 was a course in which the teacher was being graded instead of the student. Since the instructor grades the drawings, the student has to "learn the teacher not the book....". Mr. Templin feels that the students are being graded "on what our teacher knows."

I think Mr. Templin missed the whole purpose of the course. Drafting is an individualistic art that is governed by rules that differ from teacher to teacher; from company to company. When a person is employed by a company as a draftsman, he finds that each company has its own standards of good drafting practices. He must be able to adapt himself to the rules, or else the the work he produces will be wasteful and useless to his employer. The same holds for G. E. 104. Part of the course is learning the methods for solving the problems, and the other part is learning to produce what the instructor wants.

Peter Vallandigham
Sophomore in Mechanical Engineering

To the Editor:

The Student Branch of IEEE was in danger of exhaustion last spring. The organization lacked student support and would not respond to the efforts made by its officers. The same is true now. Of the more than 1200 undergraduate students in Electrical Engineering only 37 are members of the Student Branch of IEEE. Actually, most undergraduates have never heard of IEEE — the Institute of Electrical and Electronics Engineers, Inc. All electrical engineering graduate students and faculty make use of the variety of magazines IEEE publishes, but contribute little time to the Student Branch. The success and reconstruction of our Student Branch must begin with the students because the Student Branch, as the name implies, was chartered *for* the student. Only through student participation can the IEEE be a success and generate more faculty participation. The question, then, arises — How do we reconstruct the IEEE Student Branch? But first, let us introduce IEEE.

The Student Branch of IEEE was first chartered on January 28, 1931 as the combined section of the American Institute of Electrical Engineers (AIEE) and the Institute of Radio Engineers (IRE). The AIEE and IRE merged in 1963 and became the Institute of Electrical and Electronic Engineers (IEEE). Student Branches were established at universities and colleges with the purpose of "the dissemination of knowledge of the theory and practice of all aspects of electrical engineering, electronics, radio, allied branches of engineering or the related arts and sciences as well as the furtherance of professional development of the student." The Student Branch of IEEE is then a technical society dedicated to the electrical engineering profession.

Reconstruction begins with new officers who can offer enthusiasm and a creative imagination. The selection of officers last spring seemed at first rather difficult since only two IEEE members submitted applications for office. Ten James Scholars in Engineering were recommended as officers upon the request of the IEEE Student Branch Counselor, Professor Egbert. None of the students interviewed were IEEE members nor familiar with IEEE. Now the executive council for the Student Branch of IEEE is composed of seven officers all with ambition and an unprecedented creative imagination. Since their election last May, the executive council has met three times. A new philosophy for student programs has been initiated and preparations for a successful year are well under way.

The new philosophy is threefold. First, we seek more student participation in programs and activities. Our goal is to let more students share in planning and supervising IEEE events. This is done by appointing student committee chairmen for each activity and rotating among the members the responsibility of introducing our various speakers at the branch meetings. Second, we seek a different type of program for our meetings. Students will not participate or attend meetings when the program is a technical lecture which may be above their level. The classroom is the place for lecture and five days a week is enough. For this reason we have picked programs which offer non-technical topics of student concern and technical presentations based upon demonstrations of interest to students.

Lastly we strive toward professional development. Our interpretation of professional development includes those activities which mix business and pleasure. Student participation rests upon friendships among the students and very few friendships are made between students in classes, especially at the freshman and sophomore levels where many engineering students take common programs.

Our philosophy has been initiated. For the first time in its history the IEEE Student Branch held a summer meeting. On July 25, 1967 eighty-eight summer students turned out to see Prof. Don Bitzer demonstrate and explain his new plasma display panel. A graduate student, Roger Johnson, introduced the speaker. The program was a success, and the officers obtained valuable experience for the fall. Before school started this fall, Steve Taylor, a student IEEE member accepted chairmanship for the IEEE picnic. Faculty attendance was unprecedented at the picnic, and though the faculty won the football game and two out of three volleyball games, everyone enjoyed the Sunday afternoon. Hopefully, the picnic will become an annual affair so students can meet informally with the instructors and both can enjoy the competitive sports.

This is only the beginning of the 1967-68 academic year for the Student Branch of IEEE. We hope electrical engineering students will take the opportunities offered by their Student Branch. Furthermore, we hope all engineering students will participate in their technical and professional societies. These societies reveal new horizons of technical and professional merit. General McArthur has said, "There is no such thing as security, only opportunity." Take this opportunity to participate in your engineering technical society and secure your future. The classroom provides only a part of your education.

Donald Brewer
Chairman
IEEE

To the Editor:

Although the subject of this letter has been stated many times in the past, it is again necessary to throw some light on a "darkened" area in the engineering curricula. This area is the instruction in our basic physics courses, 106, 107, and 108.

In *"A Mandate for Change — Physics"* of last December's *Technograph*, the staff presented a reasonable argument for modifications in the physics department. They did not, however, include one vital area of instruction which is as important and, in some instances, more important than the long, drawn-out derivations of formulae. This area is the testing of the students' knowledge of the course material.

A student can often benefit more by a test which adequately and honestly measures his ability than from one that is designed to "weed out" the superior students from the average by means of questions which are at times so abstruse as to completely lose both the student *as well as his quiz instructor* in a hopeless state of confusion. Tests should not be of the mere "plug in the numbers and crank out the answer" type, but instead, should be designed with the concept that a student learn as he's taking an exam. He should be able to gather previously learned information to form new concepts and then be able to apply these concepts to the given problem. This is only partially what is being done.

I know of several incidents where a lecturer who had designed a test was disturbed to find the mean on that particular exam to be around 50% instead of the anticipated 30% or 40%. What is to be proven by such tests? One lecturer has stated that these exams are built to seek out the "cleverest" student. What of the other pupils?

American education, unlike that of the U. S. S. R. , is (supposedly) geared to the average student. At times I find this hard to believe. I have come to this school to learn and, frankly, find it difficult at times because of barriers such as those imposed by the physics department.

If this letter influences even one physics instructor, we are that much closer to a solution to this confusion. It is my sincere feeling that physics could be both enjoyable as well as challenging as has been stated many times in the past. I only wish that the physics department would take more time in evaluating its policies before presenting its material to the student.

Jim Thompson
Sophomore
Civil Engineering

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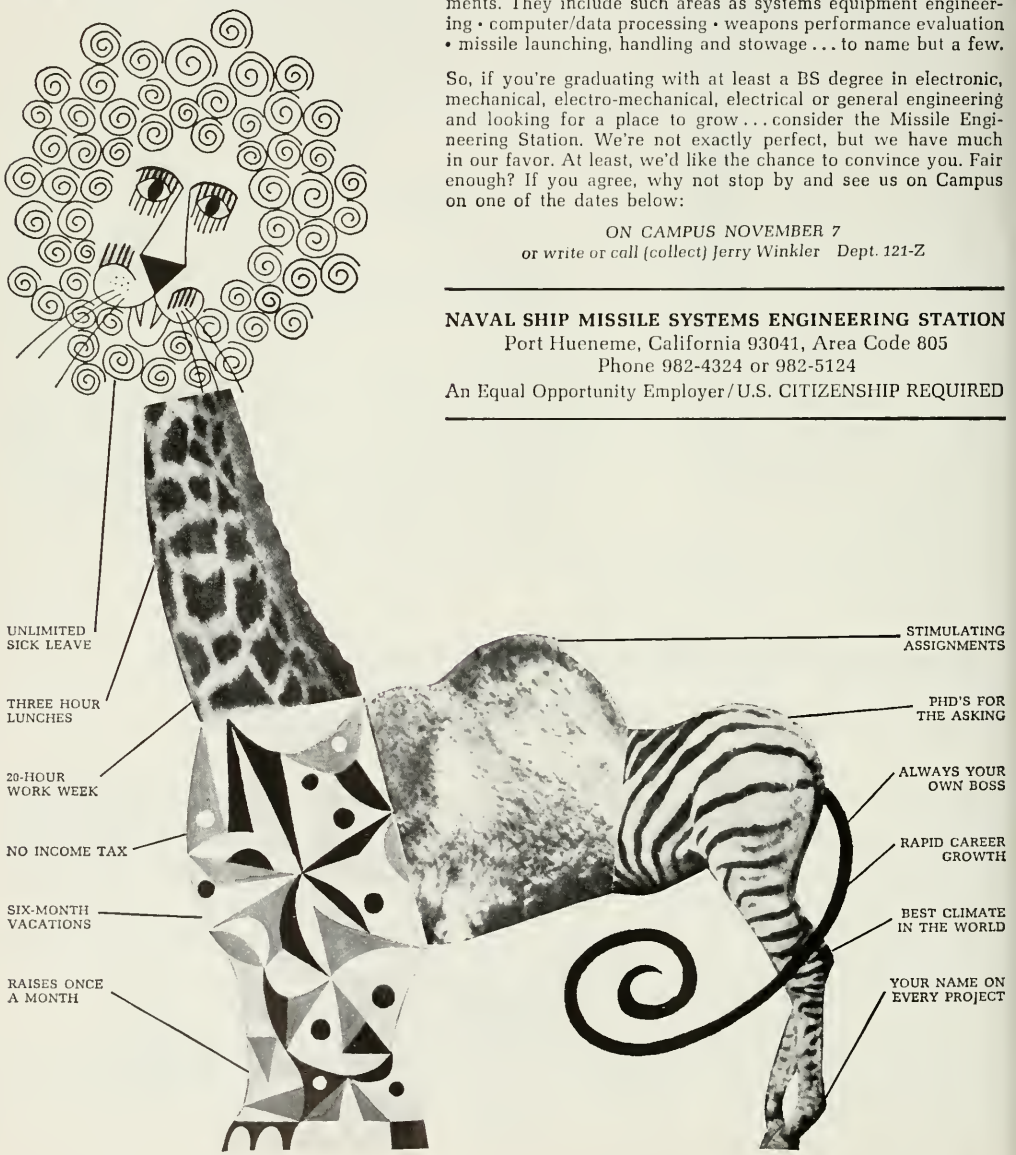

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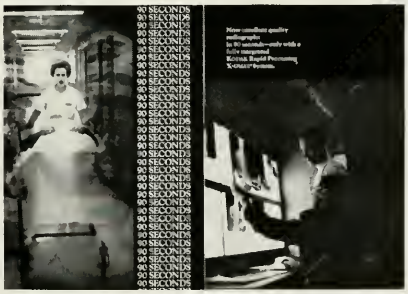

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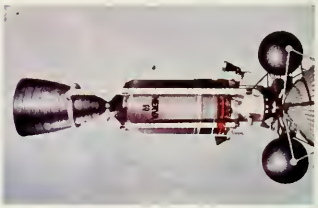

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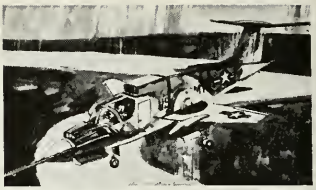

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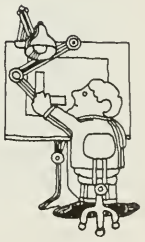

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NOVEMBER 1967
Vol. 83; No. 2

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COVER

The futuristic city on the cover is TEMENOPOLIS ONE, designed in the Graduate Urban Design Studio of the University of Illinois.

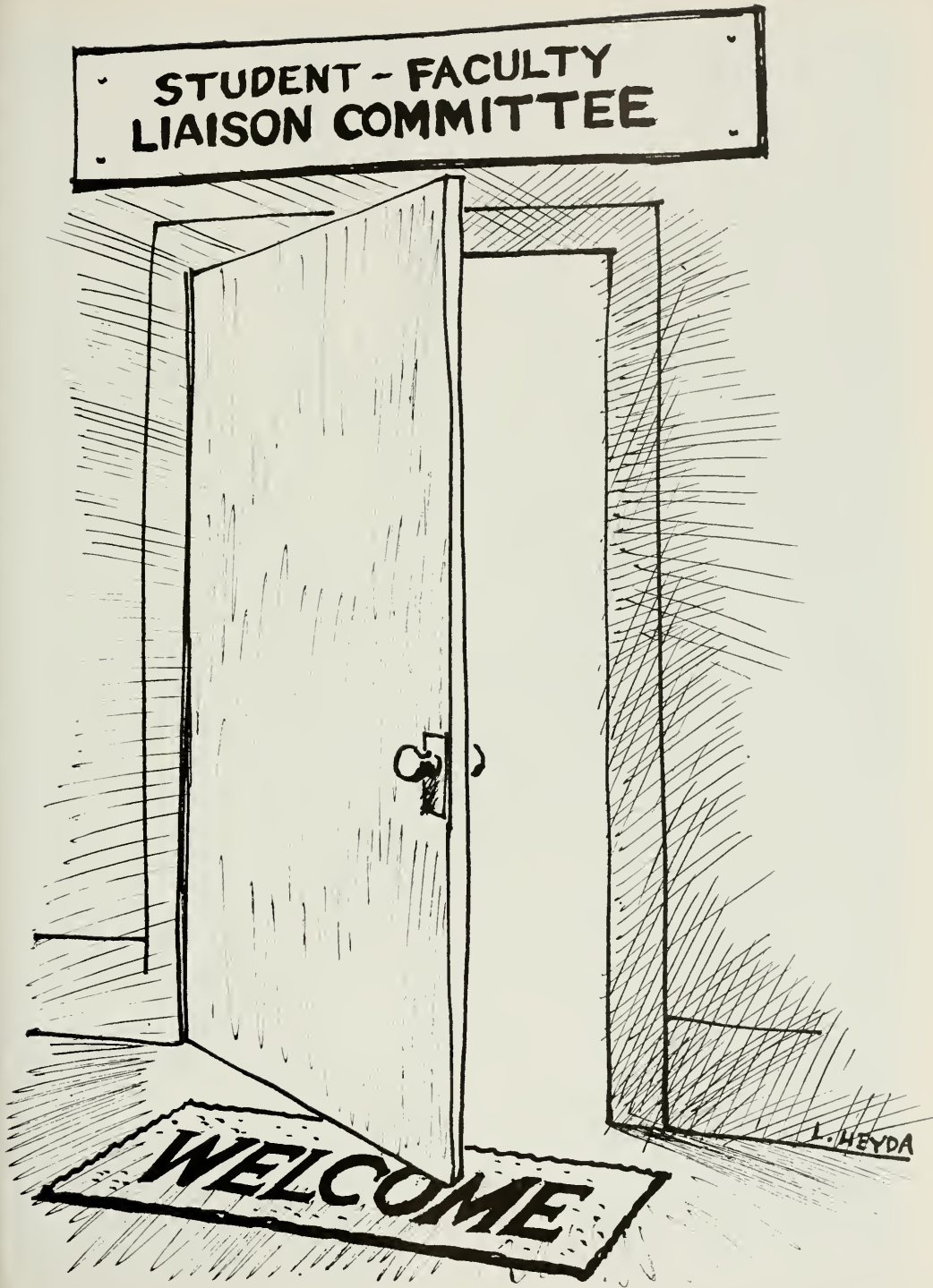
editorial

Every two weeks a group of students and faculty assemble to discuss new problems and ideas in engineering education. This group is called the Student-Faculty Liaison Committee. It is a college-wide committee comprised of students and faculty from every department. Within this group such needed innovations as six hours of free electives for every curriculum and a pass-fail system of grading have taken roots and grown into realities.

The student members of this committee are traditionally: the TECHNOGRAPH Editor; the President of Engineering Council; and a few student leaders. It is true these students are in most instances more aware of the changing needs of engineering education than the average student. Nevertheless it is impossible for this handful of student leaders to know and to present to the faculty and administration the opinions and ideas of the entire student body. At best they can represent only a handful of opinions.

A few weeks ago during a meeting of the Student-Faculty Liaison Committee this problem of acquiring true student opinion was brought up. It is not a new problem and this is certainly not the first time it has been given serious thought. In fact one might wonder if the problem really deserves consideration since most students seem to have little interest in educational affairs. However possibly some students do have ideas on how their department or College could be improved but simply do not know where to voice them. To all students the Student-Faculty Liaison Committee offers an invitation to attend one of their meetings and present these ideas. Contact Dean Wakeland or the TECHNOGRAPH Editor for dates of the meetings.

In the college, the Student-Faculty Liaison Committee is without a doubt the most active and influential committee in which students have a chance to participate. Hopefully now more students will realize they do have a place where they can express their opinions and get some action!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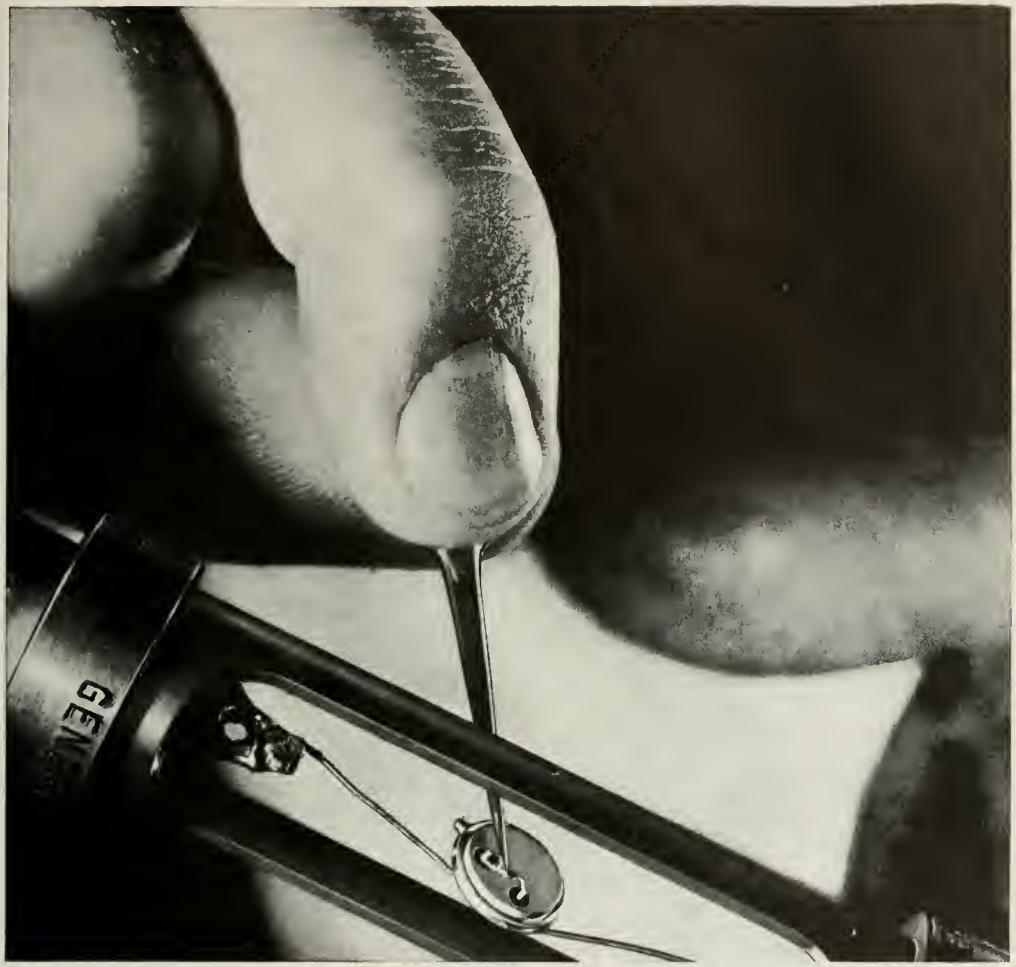

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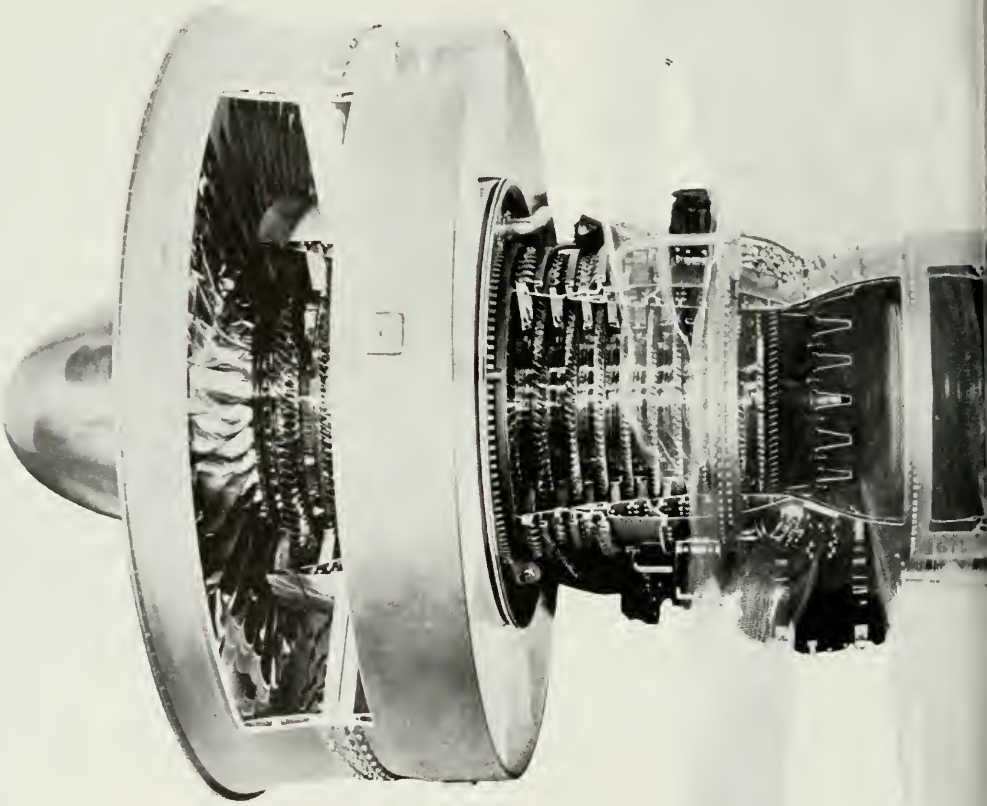

...they're right. And wrong.

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ENGINEERING FOR THE 21st CENTURY

By Robert Giertz

Robert Giertz is the General Chairman for the 1968 Engineering Open House. Bob, a senior in Engineering Mechanics, is also a member of Engineering Council.

For over fifty years Engineering Open House has been an integral part of student activities in the College of Engineering. This is the centennial year which makes visitors particularly welcome. Our engineering students, as well as our visitors, will have an opportunity to participate in the wide variety of Engineering Open House events on March 7, 8, & 9.

Engineering Open House is going to be a prominent part of the Centennial Celebration. The exhibits, designed and displayed by students, will show visitors what an interesting and exciting field engineering has come to be over our first century. Let me emphasize, however, that our purpose isn't to show visitors a historical sketch of engineering. In fact, our theme is Engineering for the 2lst Century. We will show our visitors what is being done on current and developing engineering problems. How do we build in the ocean? What do we do about air and water pollution? What are the hopes for medical electronics? Does Illiac IV think? Exhibits and lectures answering questions such as these will explain the technological world in which we live.

Tours through DCL, CSL, and the "Black Box" will both enchant and inform our visitors. A discussion with the tour will show guests how engineering technology is constantly changing. Often high school students have the idea that engineering is just a matter of playing with the right "laws"; they don't realize that new "laws" are being implemented constantly.

As usual, anyone from anywhere is invited to attend. This year, however, we are also making arrangements for approximately 1000 special guests. The program will provide direct contact with high school students who are qualified to become engineering students and their counselors. Each guest will have an individual student or faculty host with whom he can attend demonstration classes and laboratories, Centennial Celebration events, and a dinner sponsored by the College of Engineering. We hope that this personal contact will give visitors a first hand view of engineering education and of the background necessary to pursue an engineering career.

The program for the special guests promises to be an exciting one. On Thursday March 7 they will attend an address by Mr. Daniel P. Moynihan. He was formerly Assistant Secretary of Labor and is presently head of the M.I.T.-Harvard Joint Center for Urban Studies. *Time* has called him "the most controversial of urban analysts."

Also on Thursday our special visitors will attend a panel discussion with some of our distinguished engineering alumni. These men will be returning from the mysterious world of industry to tell guests what engineers do "on the outside". Guests will discover that not all engineers do research; some of them venture into sales, production, design, and management. These programs and many others will be of interest to both selected guests and those fortunate few chosen as hosts.

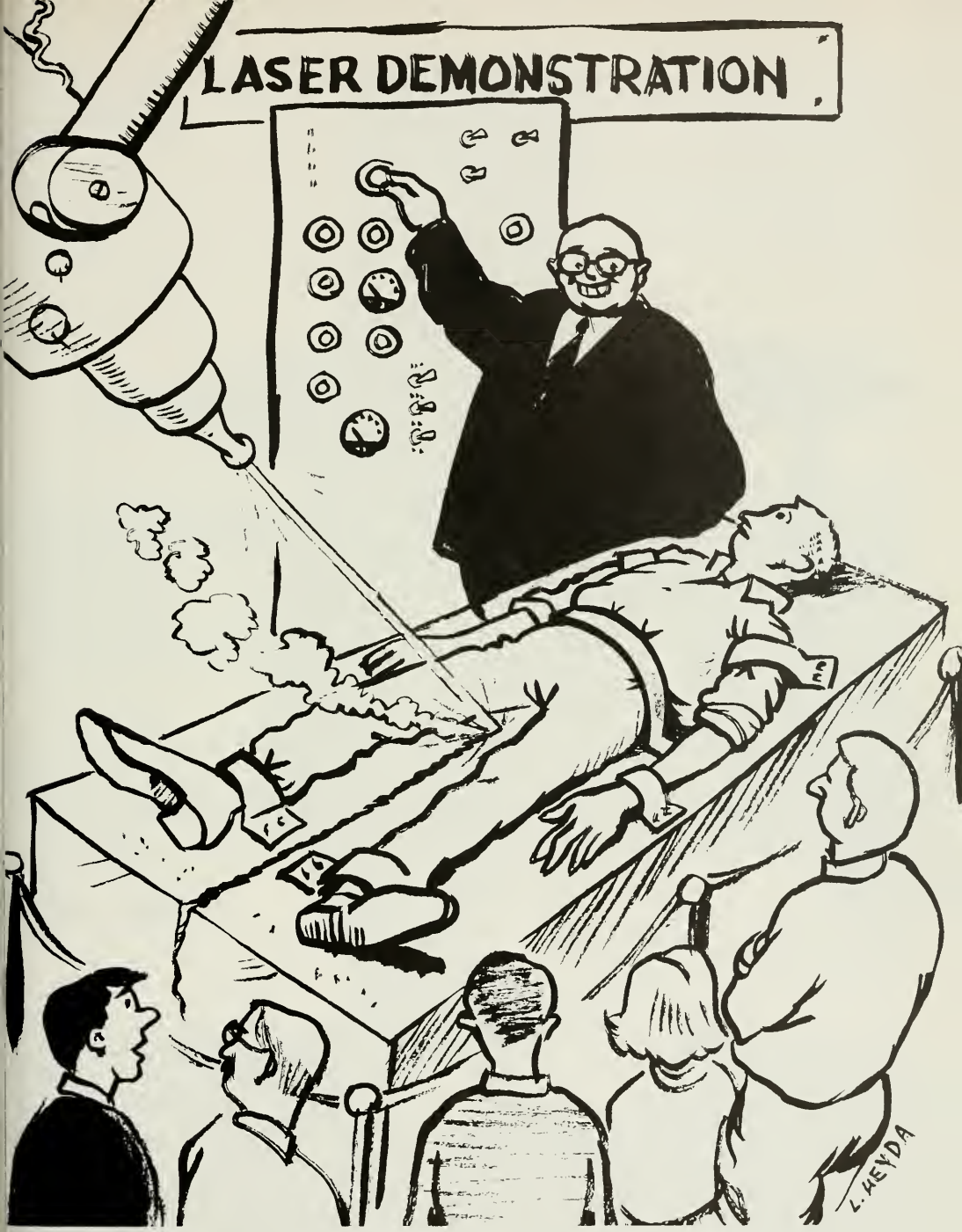
How can you as an engineering undergraduate profit from the activities on this weekend?

You could volunteer to be the host of a high school student who has interests similar to your own. You would help make a great weekend for someone, and you would participate in an interesting and informative program as well.

You might want to work on an actual exhibit within your particular department. Students who have created exhibits in the past have gained a better insight into the challenges of their field.

You could also work behind the scenes as a member of the Central Committee. As a member of the Central Committee you will be an integral part of creating the most massive event on the Engineering Campus.

No matter where you work, you profit from the experience. If you would like further details, please feel free to contact me.



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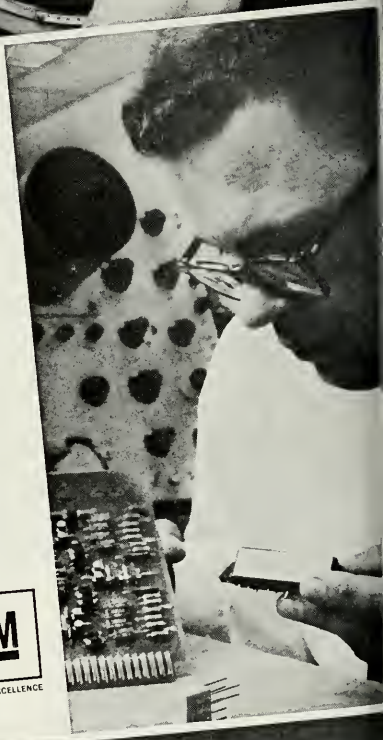

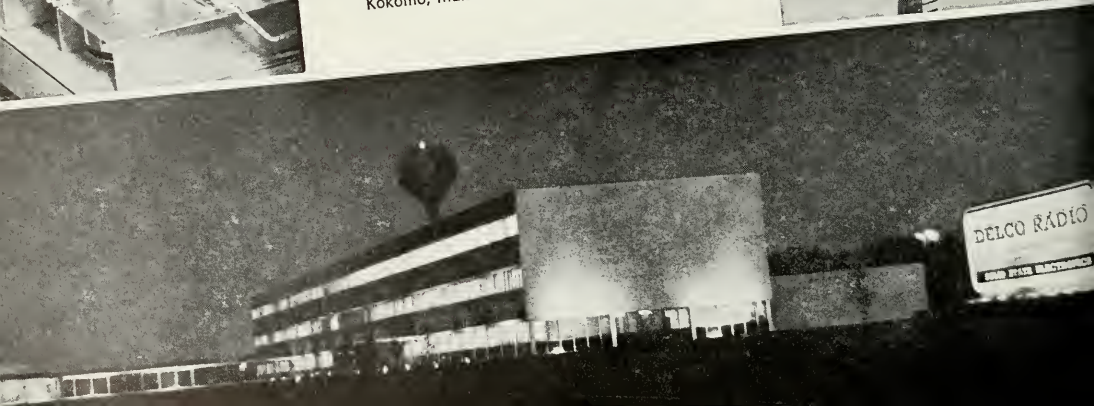

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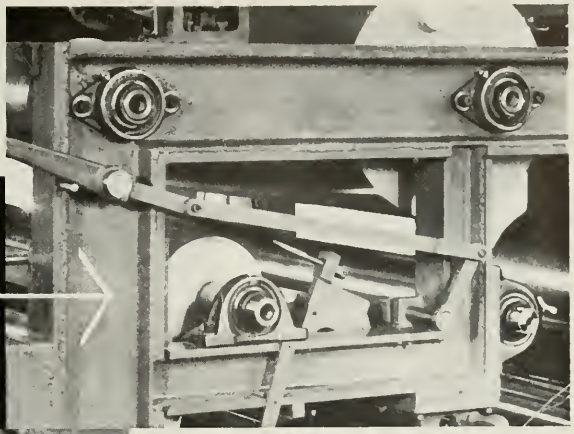

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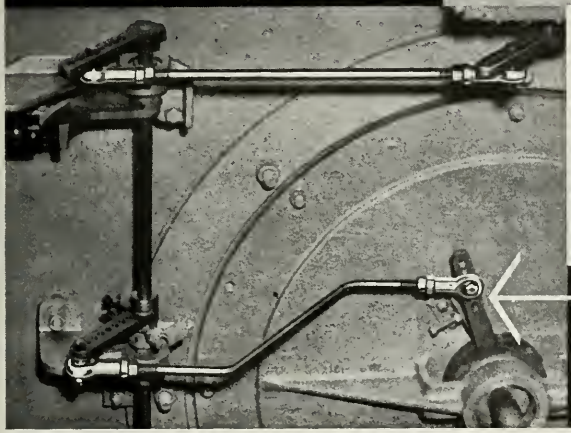

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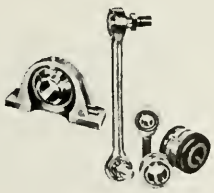

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DR. MARGARET MEAD

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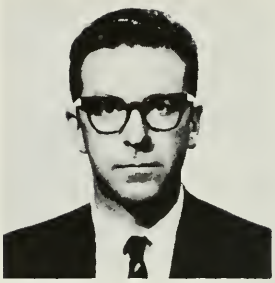

DR. VICTOR URQUIDI

"When dealing with the city, we are not dealing with just land, bricks, or concrete, but with people, human beings who must live and work together."

CITIES OF

The crisis of the American City is now. The air is polluted, the traffic congested, the inhabitants dissatisfied. The city is truly one of the greatest and most complex technological and social challenges our generation will face. Recently, Lions International sponsored a symposium concerning the city of the future. Alan Halpern was invited to attend and report for the Engineering College Magazine Associated membership.

The City — our generation's Great Frontier. To Shakespeare, "the city is people; to Henry Adams, it was "a great unpleasant body"; to Thoreau, it was a place to be avoided," which he did; To Theodore Dreiser, it was a "handsome woman with a cruel mouth"; to Thomas Jefferson, it was a "pestilence to the morals, the health, and the liberties of man"; to Laurence Halprin, the city is "a total environment for the total process of living"; to 70% of Americans, it is home. Plato feared the disorder and confusion of the city while Aristotle thought the "best limit to the population of a city is the largest number which suffices for the purposes of life and can be taken in a single view".

Today, though, one thing about the city is clear, the cities of the world are in trouble, a crisis is at hand, a crisis which next to the pursuit of peace and the preservation and perpetuation of our resources is exceeded by none.

A BRIEF HISTORY OF THE CITY

Even with our eyes on the horizon, it is totally relevant that we have an understanding of how our cities grew to their present state. Urban societies and those in which people lived in high densities first appeared about 3500 B. C. Cities evolved when man rose above the agricultural subsistence level. It was division of labor followed by the development of technology and social organization that formed the basis for urban life. As Lewis Mumford writes, "In taking form, the ancient city brought together many scattered organs of common life and within its walls promoted their interaction and fusion. Through its concentration of physical and cultural power, the city heightened the tempo of human intercourse and translated its forms that could be stored and reproduced. The city became capable of transmitting a complex culture from generation to generation."

DR. PETER HALL

"It is possible to regard the American Far West as a sort of vision of the entire western world about the year 2000."

DR. JAMES ROUSE

"The only legitimate purpose for our cities is to grow better people, more concerned, inspired, fulfilled — more loving people."

DR. MASATOSHI MATSUSHITA

"The very survival of humanity is dependent upon world wide urbanization."

By Alan Halpern

THE FUTURE

It was not until the 19th century, however, that large scale urbanization took place. Forged by the advent of industrialism, improved agriculture, transportation, and communication, vastly fewer numbers were needed for agriculture. Only through this surplus can societies emerge and prosper. The city became a magnet — a meeting place for trade, mutual benefit, and protection. A German contemporary of Thomas Jefferson, Justus Moeser, observed that "specialized division of labor forces workers to live in big cities." And so it was, with great waves of migration from the country to the city center where workers came for employment. Industries and business services in turn located there because of the accessibility of a variety of goods, services, and labor.

Until automobiles, travel in the city was by means of hoof or foot, which according to Hans Blumenfeld, placed a realistic limit of about 3 miles radius for the city. Until elevators were invented, a limitation was also placed on the vertical expansion as well. The city continued to grow in this fashion, with shops, homes, industrial plants all clustered, covering every foot of property. The automobile and mechanized transportation changed all this, however, and the American city has how entered a new stage of development. The migration from the rural areas still continues in burgeoning numbers, but in addition there is a counter trend, a powerful centrifugal migration from the city to the suburbs. The interaction of these two trends has produced a new breed of settlement whose influence extends far beyond the traditional boundaries of a city, "where the city flows into suburbs, and the suburbs flow into other suburbs and become the unplanned crazy quilt of magalopolis." The forces are already present in 14 areas of the world for the formation of giant megalopolises, housing tens of millions of people, including in our country the East Coast Corridor, an area between Detroit and Chicago, and the West Coast region.

THE GREAT FRONTIER

Our civilization has come to the fork in the road, unprepared, only to discover that history has provided us not with roadmaps and blueprints, but mere vestiges of a sometimes splendorous, sometimes downtrodden past. In 1905, the average speed of travel to cross New York City during the rush hour was 9 mph — it is still the same. We are confronted with the very

startling reality that the cities of the present are not as livable as those of the past. We are moved to ask whether this is progress.

Of the city, one critic has written:

> You praise the men who feasted the citizen and satisified their desires, and people say that they have made the city great, not seeing that the swollen and ulcerated condition of the state is to be attributed to the elder statesmen: for they have filled the city full of harbors and docks and walls and revenues and all that have left no room for justice and temperance.

The critic's words were not directed at our cities, although they are relevant, but to a city of a golden age. The city was Athens and the critic Socrates. History is testimony to the oft-repeated cycle of expansion and disintegration of nations unprepared to consider or meet the challenges of the future.

The vast slums of the city speak of its cruelty, the racial ghettos of its callousness, the traffic congestion of its obsolescence, the sprawling perimeter of its cancerous growth, the air pollution of its danger to health, the crime and rioting of the dissatisfaction and alienation of its inhabitants. To one urbanologist, our cities are ugly, incoherent, sprawling, cultural wastelands — anti-cities.

THE SYMPOSIUM — A "SUFFICIENTLY BOLD STEP"

It was on this stage that the panelists spoke at the symposium: our physical environment in turmoil, our people more impatient, our lives unjustifably more complex, and in our possession the resources to shape the quality of American life in almost any fashion we choose.

In an effort to contribute its share to the betterment of our cities and the lives of its inhabitants, Lions International sponsored a three day symposium in San Juan, Puerto Rico, to discuss the problems and formation of the city of the future. It was a significant step by an international service organization, recognizing that although piecemeal contributions are worthwhile, they are inadequate, that regardless of the extent of one's commitment, truly effective plans must be comprehensive.

DR. MARGARET MEAD

Dr. Margaret Mead is the Curator of Ethnology of the American Museum of Natural History and Professor of Anthropology at Columbia University. She is considered to be the most famous living anthropologist in the world today. Her major interest is the study of contemporary culture in the light of the perspective gained by examining small homogeneous stable societies.

The Swedish government has taken the lead in c
they have built high density communities linke

THE CRUCIAL ROLE OF THE SMALL CITY

Dr. Margaret Mead, the opening speaker for the symposium, called for the preservation of the small city. Dr. Mead directed her comments to the small city, believing that "in its regeneration and creation lies the answer to many of our urban ills. The small city can give the people from the country a chance at a job, a chance at decent living, a chance at leisure. Is what's happening to the cities in the world inevitable? Are we inevitably bound for the megalopolis? Is every country in the world going to be dominated by a few very large cities that gradually absorb about all the arable land and become worse and worse?"

To all of these questions, Dr. Mead responded in

PHOTO BY SWEDISH INFORMATION SERVICE

ommunities. As an alternative to sprawling suburbs, id to each other by modern mass transit facilities.

the negative, with a qualified answer. "If we think this is inevitable, we will plan for perfectly horrible bee hives, but if we think it is not, I believe that we have a choice, but we are not going to have it for very long." Dr. Mead emphasized, as did all the speakers, the very precipitious position our generation holds. "The choices we make now and the amount of concrete that we put down in particular places are going to determine the pattern of the lives of the next generation. We are in an extraordinarily responsible spot."

Dr. Mead continued in her very perceptive description of our present position. "Perhaps the best thing that one can say about any generation is that they didn't let anything irreversible happen, that they haven't tied the hands of the next generation." However, she lamented, "if we let soil erode and if we pollute the water, if we kill our lakes and poison our atmosphere, we are doing something that may not be reversible at all."

Her attitude, however, was one of concerted optimism, that "what man has made, man can change," but she added that "there is no possibility of simple national solutions to the whole problem of cities. A city is considered stagnant if it is not growing, but with this growth comes the complexity and the chaos that have vexed modern urban communities. The problem for the small city is," as Dr. Mead explained, "to grow in quality without necessarily growing in quantity of population. Size is not the determining issue, for a city must have its quota of cultural institutions, universities, libraries, museums . . . a city without has no soul."

"The small city with a clear stamp of development is the ideal place to produce the leaders of the nation." The suburbs came under sharp criticism for their segregated living, both economic and racial, conditions not generally prevalent in the small city. "Think of growing up all your life and never meeting anybody but junior executives."

In Dr. Mead's opinion, "one of the things that the present urban living is doing is cutting people off from an understanding of the whole — a whole city, a whole country, and we have to give it back to them if we want to produce the kind of people we need."

DR. PETER HALL

Dr. Peter Hall is a professor at the London School of Economics and Political Science where he specializes in geography with particular reference to regional planning. He is regarded as perhaps the outstanding young city planner in Great Britain.

THE URBAN CULTURE AND THE SUB-URBAN CULTURE

Dr. Peter Hall presented a penetrating analysis of the contrasts between European and American urban and suburban cultures. It was Dr. Hall's purpose to explore these differences and discern their influences for our future. "Although all urban communities have many common characteristics, they also exhibit remarkably different physical expressions. A traveler viewing the North American urban landscape is overwhelmed by the scale of the development, by the apparently endless sprawl of suburbs in the East Coast magalopolis, by the vast networks of freeways which link them. Observing Europe, on the other hand, he is suprised by the puniness of the development, by its toytown-like quality, by the planned precision."

In Britain, Dr. Hall relates, "the government determined upon a vigorous policy of regional planning to limit the further growth of London. Remarkable as it may seem, they succeeded in stopping the growth by the creation of a green belt, 5 miles wide, around the city to be used for agriculture and recreation facilities."

Whereas European communities have grown in high density centers usually linked by rapid transit system such as the new suburbs of Sweden, American communities have continued the sprawl, a pattern so radically different as to be a different type of culture, the suburban culture.

"The new American scene is characterized for its waste, increased commuter time, for its basic lack of form where each building is treated in isolation, nothing binding it to the next. To this roadside civilization of the gas station and the hamburger stand, this tasteless, exuberant, sprawling culture has been given the word: goop. This form is most prevalent in California where the whole concept of a city has lost its significance to become known as the nonplace urban realm by many." The opinions of urban specialists concerning the progress of suburban living are by no means unanimous for as the moderns argue, "new systems of communication have exploded the centuries-old association between propinquity and communication." The contrast between Southern California and centralized Europe is extremely important, for as Dr. Hall notes, "California had by 1925 reached the general living standards, and in particular the level of car ownership of Europe in the 1960's. It is possible therefore to regard the American Far West as a sort of vision of the entire western world about the year 2000." This is an extremely profound observation, for if this is to be, we must ask ourselves whether the suburban culture represents an improvement or an impoverishment of human life and human possiblilites in comparision with the old urban culture. To some, the suburb offers a desirable life style, while many contend it is a life of homogeneity, conformity, and an atropy of diversity. The academic debate will continue, but the burgeoning suburban population seems to indicate that the advantages outweigh the shortcomings as far as the consumer is concerned.

The importance of system planning and comprehensive control was never more necessary for as Dr. Hall emphasized, "It will be the task of the planner to offer choice to the individual. This enhanced choice to the individual can only be achieved, paradoxically, through a greater degree of government intervention."

The preservation of individual identity in a city of millions is truly the task of our generation. We must design a city which as Lewis Mumford relates "will make man at home with his deeper self and his larger world."

PHOTO BY KAISER ALUMINUM AND CHEMICAL CORP.

DR. MASATOSHI MATSUSHITA

Dr. Masatoshi Matsushita is the former President of Rikkyo University in Tokyo, Japan. He is a recognized authority in both International Law and International Relations.

CITY REBUILDING AS NATIONAL PLANNING

Dr. Masatoshi Matsushita looked to the future of his country, Japan, only to find very grim consequences of the extension of the present trends. "The very survival of humanity is dependent on world wide urbanization. The city of the future must be prepared to deal with the rising population. Cities must be built in international context."

"There is a likelihood," Dr. Matsushita prophesied, "that Tokyo will someday be a city of 200,000,000 people." In the view of many experts, this is not only possible, but altogether likely. Replacement of transportation by communication is the central feature which will allow cities to reach this size. The advent of 3-D color television and other advanced techniques which may replace our telephone systems, will in Dr. Matsushita's opinion "eliminate the need for businessmen to leave home." In years to come, automation and technological advance may allow a man to work only an hour a day, and this will be done from his home. The important question of whether our civilization will be able to move from a work ethic to a leisure ethic becomes quite pertinent for our discussion of the future.

DR. VICTOR URQUIDI

Dr. Victor L. Urquidi is a consultant to the Ministry of Finance for Mexico and a consultant on development for the Bank of Mexico. He has played a leading role in developing the Central American Common Market Organization.

THE UNDERDEVELOPED CITY

Dr. Urquidi commenced his presentation with the obvious, but often neglected fact that "when dealing with the city, we are not dealing with just land, bricks, or concrete but with people, human beings who must live and work together." Working as a development economist in the underdeveloped city, he pointed out the very real possibility of the permanently underdeveloped city, for it is in the underdeveloped countries that 2 billion people reside, a number which will grow to 4.7 billion by 2000 A.D. At this time, the less developed countries will contain three-quarters of the world's developed resources and industry.

"Latin America," in Dr Urquidi's view, "is poor and run-down with splashes of wealth interspersing ugly slums. The nations are beset with the premature city, reception centers of poor and rural migrants . . .

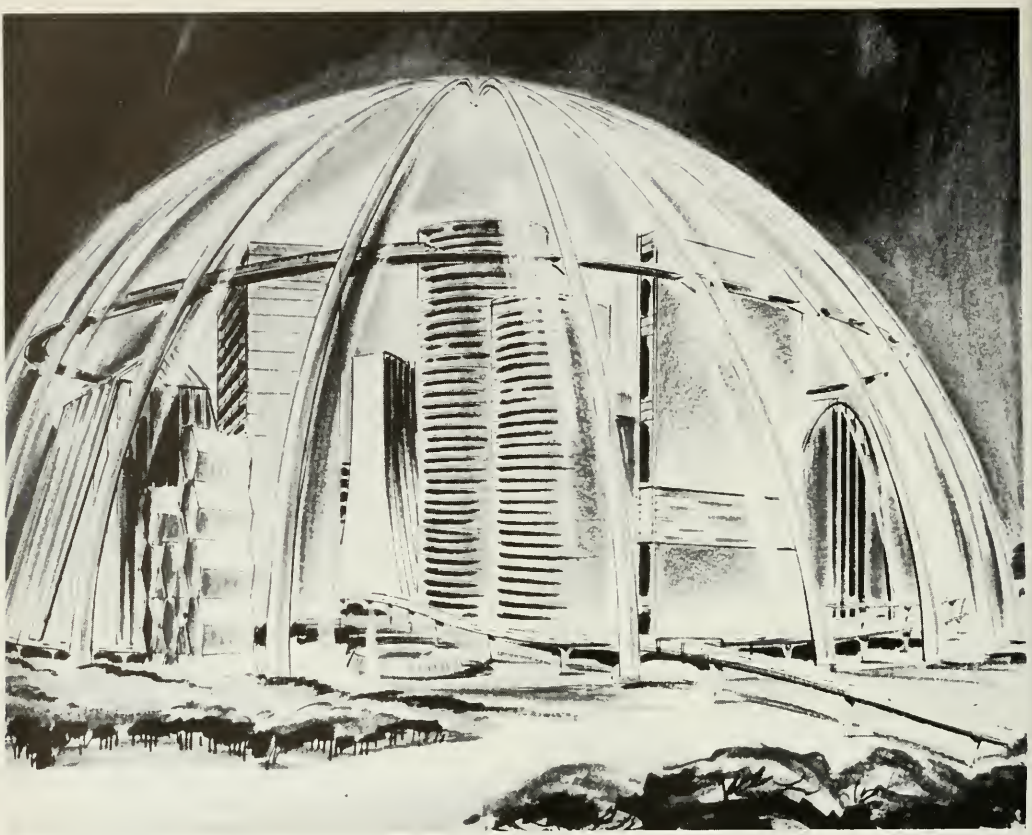

PHOTO BY GENERAL ELECTRIC

Many architects foresee whole cities protected under the umbrella of giant domes. R. Buckminster Fuller, inventor of the Geodesic Dome has predicted that a dome over Manhattan Island would pay for itself by the savings of air-conditioning and snow removal.

Slum dwellers may number ¼ to ½ in many of the larger cities. To say that the problem is insoluble may not be far off the mark if present attitudes persist, for town planning in Latin America is almost non-existent; most solutions are short term solutions to problems that have not been adequately defined.

"However, one of the most serious obstacles to progress is that the countries are being forced to adopt the aspirations and patterns of high income countries and made victims of rural political systems." In Dr. Urquidi's opinion, "the city dwellers cannot be regarded as contemporary or middle class groups. Urban planning which in the past has been devoid of economic content and unconcerned with the present starting conditions of the city, must become an integral part of the social process. If there is to be progress, city government must come within the scope of national planning. Concepts will require significant revision, for we are challenging a system, a society which has failed to respond to the needs of the people."

MR. JAMES ROUSE

Mr. James Rouse is President of the Rouse Company, a mortgage, banking and real estate development firm. The Rouse Company has financed over a billion dollars in real estate developments. Mr. Rouse was formerly a member of President Eisenhower's Advisory Committee on Housing.

CITIES THAT WORK FOR MAN — VICTORY AHEAD

Why not build a whole city? Absurd, one might respond, but to Mr. James Rouse and his firm, the idea was not only inviting, but challenging. "Couldn't such a city be not only beautiful, but also more

profitable to build?" Prodded by their answer, the Rouse Company focused on the immense problems and out of their intensive research effort has grown Columbia, a completely planned city between Washinton, D. C. and Baltimore, which in 11 years will house 110,000 people. Columbia, as Mr. Rouse states, "offers no startling innovations, no special genius, no big discoveries. It simply puts to work knowledge that is all around us. We seek to plan a city intelligently for the people who live in it. We believe it will be a beautiful, intensely human, lively, effective city.

"In the remainder of this century, we will build new in our cities the equivalent of all that has been built since Plymouth Rock. It is an opportunity to plan and develop the new one half of American cities free of the mistakes of the past, responsive to the needs of the future.

"What is happening now," laments Mr. Rouse "is that our cities grow by sheer chance. By this irrational process, non-communities are born, formless places without order, an irresponsible dissipation of nature's endowment and of man's hope for dignity, beauty, and growth." Americans have strangely grown accustomed to the disorder and inefficiency of our cities. "There is a state of mind about the American city. We have come to subconsciously accept the state as evitable . . . Sprawl is thought to be better than slum. We lack the organized capacity in America, at the present time, to produce good new communities. There is no General Motors, no IBM in city-building. No one has the capacity to undertake research and development investment to produce new communities that will match our knowledge and our needs."

THE HISTORY OF COLUMBIA

Realizing that the bits and pieces approach had failed, Mr. Rouse set out to prove that "there was a compatability between public purpose and private profit in producing a well-planned new city." A profit was a prime objective, but by using the dynamics of the market system, dreams were hauled into focus, biases tempered, and if successful the myth that it is not economic to produce a good environment would be dispelled. The city had four objectives; (1) To build a complete city, not just a suburb, (2) To respect the land, preserving the streams, the trees, the natural landscape, (3) To provide the best possible environment for the growth of people, and (4) To make a profit.

The city was born out of what came to be known as the "Columbia Process." "It is a process that begins with an honest attempt to learn what might work best for the people who will live there and then to discover by physical planning and by study and negotiation with leaders in the schools, and churches, in the health, cultural, and recreation institutions how these best hopes might be acheived."

DR. CONSTANTINOS DOXIADIS

Dr. Constantinos A. Doxiadis is considered by many to be the world's greatest living urban planner. He is particularly known for his invention of "Ekistics", the science of human settlements. Dr. Doxiadis's firm has planned and rearranged cities which now affect some 60 million lives all over the globe. At present, his firm is involved in an extensive study of the Greater Detroit area.

HOW TO BUILD THE CITY OF THE FUTURE

"No matter what we say about how bad the cities of the present are — and they are bad; no matter what we say about the causes of the trouble we are in — and we are in trouble; no matter what dreams or plans we make for the city of the future, unless we face the problem of how to build the city of the future, we will never achieve anything. We will continue living under bad conditions in bad cities and we will suffer more." This statement by Constantinos Doxiadis is a challenge which he has made and accepted himself, to identify the problems and to set out to solve them.

To accomplish this task, Dr. Doxiadis has faced the problems in a systematic way, in stages asking himself a series of questions: (1)What is the city? (2) What is happening to our cities today? (3) How do we realize the city of the future? and (4) How do we build that city?

To Dr. Doxiadis, the word "city" is an outgrown term, for what should be used is the term "human settlement". "The era when the city was a unit of habitat very clearly defined in space has passed. The city has turned into a dynamic, growing organism."

To determine what is happening to our cities, one need look at its five elements: Nature, Man, Society, Shells (buildings), and Networks (roads, electrical systems, etc.)

THE URBAN STAGE

"The city may be viewed from many different angles by many experts, but no matter which way we look at the city, we will discover that it is in a crisis. We contaminate the air, we pollute the water. Man, the creator of the city has lost his freedom in it. The city no longer operates with the same efficiency as in the past. In fact the result is that our city turns into a city which is not as good as the city of the past. The problems which started as structural problems turned into a problem of the succession of economic and social classes and finally has turned into a racial problem, . . . a confusing situation from which all citizens will suffer . . . certainly those of the lowest income groups who by necessity fall into the worst areas of the city.

Dr. Doxiadis emphasized, that "it is time for us to understand that the way we are going to live in the cities of the future depends on the decisions we take now . . . for not only is the city of the present bad, but what we build today is leading to a city which will be much worse than the present ones. We cannot predict, we have to decide; We cannot only complain, we have to build."

THE HUMAN SCALE

Dr. Doxiadis points out that we must measure the city in terms of human values. The average American citizen spends 76% of his lifetime at home and only 24% away from it. He spends 36% sleeping, 20% working, and 10% eating, dressing, and bathing. He is left with 34% of his life for leisure and pleasure. If man spends 1½ hours commuting, it is his leisure time which is sacrificed. "The major problem of existing plans is that they extrapolate existing trends. If Thomas Edison believed in extrapolation, we would be here with a better oil lamp."

"It is completely realistic to foresee one huge universal city which would be called the 'ecumenic city' or Ecumenopolis. This city will be extra-human in dimensions; our great challenge is to turn it into a human one. To accomplish this, the city should consist of human communities which should serve as cells.

"The conception of the city of the future does not guarantee an understanding of it in all its parts, much less the understanding of how we are going to move from the cities of the present to the city of the future, but this is our task. To organize, to plan. It is important to see every urban organism as a whole, to build systems of cities, to insure growth in accordance with the needs of life."

THE PROBLEM OF URBAN TRANSPORTATION

The function of any transportation system is to move people and goods from one location to another as quickly, efficiently, and as cheaply as possible. At present our highways are overloaded and congested, our mass transportation inconvenient and irregular. If there is to be any solution it must be a comprehensive one, approaching transportation as a system of interrelated activities. The recognition that transporation systems possess a city-forming role has often been neglected. The New York subway of 1905 opened up the Bronx. Today, expressways are allowing the the growth of suburbs and housing developments.

CHANGE IS NOT NECESSARILY PROGRESS

The opening of a freeway has often increased demand until congestion on the freeway increases the travel time to what it was before the freeway existed.

John Dyckman, writing in "Scientific American" states that the "growth of urban population itself is likely to produce a situation in which scale effects rule out present modes of transportation."

In a half-hour drive from the University of Puerto Rico to the hotel, a distance of about five miles, Dr. Doxiadis and this author discussed the difficulties and possible alternatives to the present chaos. Being from Greece, he nad naturally consulted the oracle at Delphi concerning this problem and the answer, in typical cryptic form, was "Prospects of survival no death of city." Then, as Dr. Doxiadis relates the story, he sat down and envisioned the alternatives to the future of transportation, choosing in particular a trip from Delphi to New York City.

Many architects foresee whole cities protected under the umbrella of giant domes. R. Buckminster Fuller, inventor of the Geodesic Dome has predicted that a dome over Manhattan Island would pay for itself by the savings of air-conditioning and snow removal.

By one vision, he takes a helicopter from Delphi to the rocket port at Athens, from there, after a 20 minute flight, he lands at New York rocket port. There he boards an airplane which after a 30 minute wait in line takes him to the newest airport 50 miles from downtown. Guided by radar and great projectors through the thick smog, he reaches his hotel after four hours. His trip has again verified one of the new laws of transportation: the longer the distances, the shorter the time needed to cover it.

On the other hand, he foresees the possibility of travel in a plastic bubble. Stepping into the bubble at his hotel room, the bubble is automatically transported through an underground tube to the rocket port, loaded on the rocket, unloaded in New York, and by another tube, he is brought up to his hotel room. The important point is that the facilities have developed to the point that they only serve man without imposing their existence on him.

OF MEN AND MACHINES

These projections are, of course, long range, but there is something that can and must be done to alleviate our present congestion. The present highway systems, in the opinion of Dr. Doxiadis, are partial, self-defeating and short-term solutions to the program. The solution will be realized by moving automobiles through vast, underground tunnels, which will have facilities for moving all the cars at very high speeds, slowing them gradually as they reach their destination, where they may resume driving on their own power. A study by the *Rand* corporation and an independent one by Dr. Doxiadis have shown that by 1975 tunnel construction will be cheaper than present highways. "The cities will be unclogged because the cars will be removed fast enough." Unfortunately, Dr. Doxiadis believes that 15 years will elapse before any significant move in this direction is implemented in our country.

THE AGE OF URBANIZATION

It therefore becomes apparent that the future of our cities and the future of our nation and our civilization are inextricably bound. Senator Abraham Ribicoff, in his probe of the Federal Role in Urban Affairs asked this very insightful question: "Why, when the massive resources of our government have been poured into the cities for the past 20 years, when many dedicated people have worked with such resolve, do we have an urban crisis of such proportions?" We are beginning to recognize that we cannot let the momentum of the past and the assumptions which governed our cities continue to dominate their future, for as we have seen our contemporary solutions just have not worked.

We must not only rebuild and revitalize our present

(CONTINUED ON NEXT PAGE)

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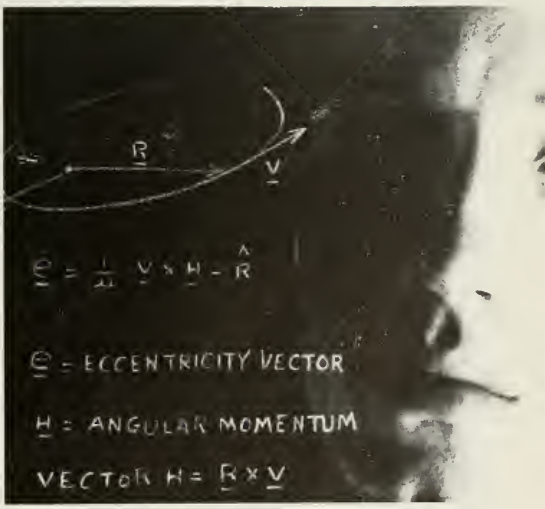

cities, we must in the next 35 years provide more housing than has existed in the history of our nation. Our planning must be provident, massive, and comprehensive. We must not just react to problems as we have in the past, we must anticipate them.

THE CITY AND THE MYTH

The city is a complex system. In the view of Robert Wood, "a multi-component, multi-input, multli-output, multi-purpose set of structures." The conclusion of a report of scientists and engineers who were called together by the Department of Housing and Urban Development was that "Our woes have resulted quite largely from our frequent indifference to the interaction between the many systems in the machinery that make the city tick." In no other area is the gap between human knowledge and application so vast. It will be the engineer and the city planner who will be called upon to rennovate our present cities and plan our new ones. This is a group of men who must be as much concerned with the man as with the building. There must be what science advisor Donald Hornig calls "A gnawing at the conscience of the technical community".

TECHNOLOGY AND THE CITY

All engineers will be forced to become human engineers, possessing the necessary knowledge of an individual's needs and the effect of technology on the individual in fulfilling those requirements. It is an absolutely essential responsibility. To believe otherwise is to ignore what 5000 years of unplanned urban growth have taught us. The city of the future offers one of the greatest challenges technology will ever face.

WHO WILL DECIDE WHAT?

We will actually have the power to decide what our environment will be. The alternatives are numerous, but it is apparent that our cities will not be formed by one sector of the population, be it government, private industry, or universities. With such power, the deceptively simple question, "Who will decide what?" becomes one of paramount importance. Science and technology unguided by political sophistication and social understanding created the nuclear arms race, incredible population growth denied the resources which technology can furnish have brought part of the world to the brink of starvation. The decisions must be made by those capable of viewing technology on "the human scale."

MAN AND THE CITY

Of greatest importance is the effect of the city on the individual, for as Churchill has written, "We shape our cities then our cities shape us."Our cities must be built to enhance the individual, not crush him with anonymity, to enrich his life, not stultify his creativity. Kaiser Aluminum News has written of the city: "It is diversity, not size, that makes a city. To diversity, it owes its essential magnetism; it is the richness of experience and the variety of opportunity that draws men to seek the city. This same diversity binds them to its spell. It is to the preservation and creation of diversity that the city will owe its future life."

To achieve the "city of man", our institutions, our planning concepts must be drastically altered. A comprehensive philosophy must emerge. Only if our plans are powerful and comprehensive will they be able to guarantee freedom, diversity, dignity and opportunity for all our citizens.

Human values must not fall at the cost of efficiency in the city of the future. "The magnitude of the effort must be matched by the quality of the planning." We would be wise to note the words of Edwin Markham in "Man Making":

Why build these cities glorious
If man unbuilded goes?
In vain we build the world, unless
The builder also grows.

Alan Halpern, the author, was fortunate in being able to talk with many of the panelists. In this picture are, from the left, Dr. Peter Hall, Dr. Victor Urquidi, Dr. Constantinos Doxiadis, and Halpern. Alan is a senior in electrical engineering, a former Editor of the Technograph, the publisher of HORIZONS IN ENGINEERING, a member of the Student-Faculty Liaison Committee of the College of Engineering, and a member of Tau Beta Pi, Eta Kappa Nu, Omicron Delta Kappa.

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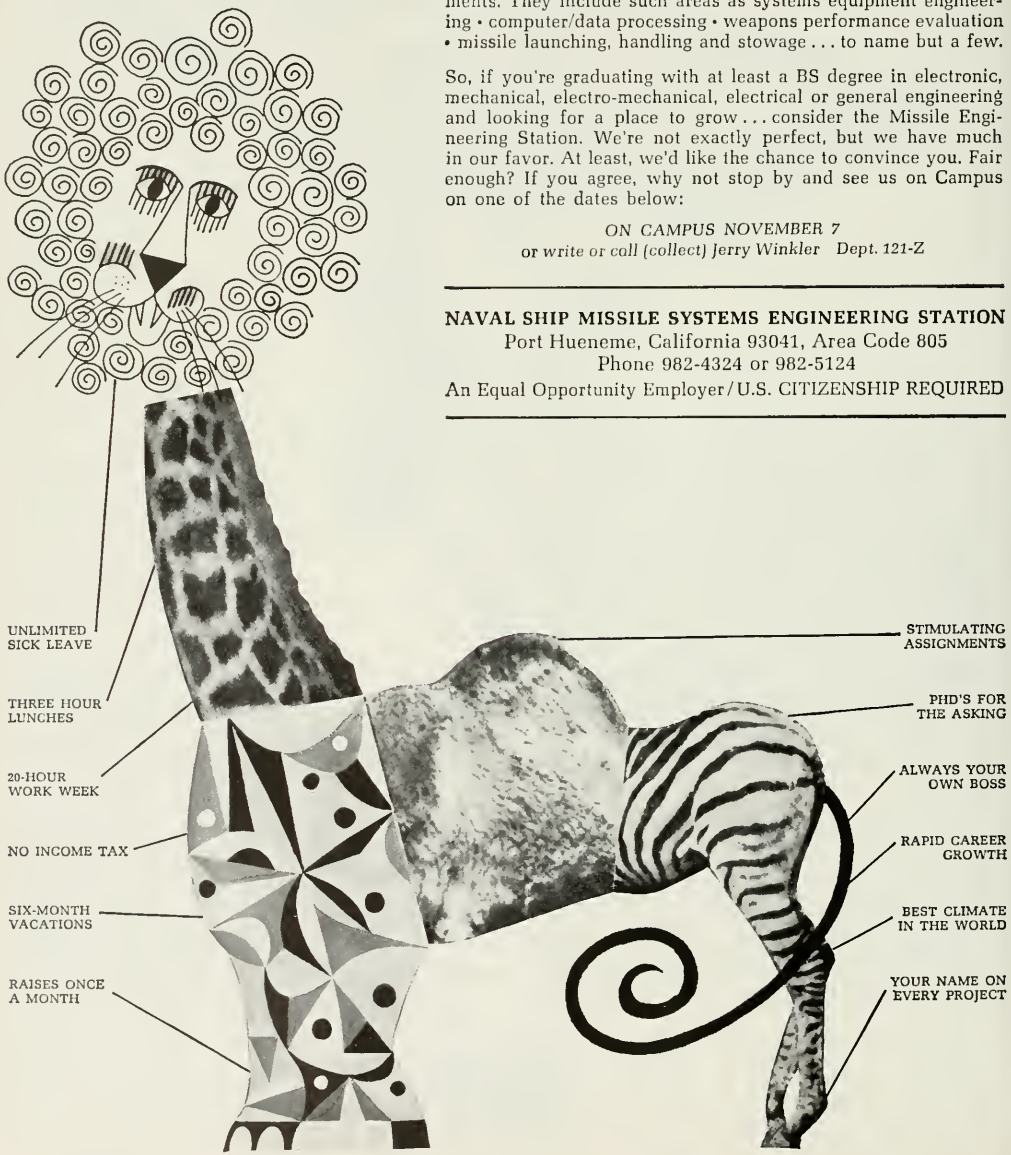

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The movie industry may feel the same way about words such as colossal, gigantic, sensational and history-making. They're good words—good symbols. But they've been overused, and we tend to pay them little heed. Their effectiveness as symbols is being depleted.

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How Union Carbide started a boom in Minnesota.

70 years ago, Minnesota's Mesabi Range was like a loaf of raisin bread. The raisins were pockets of rich, soft iron ore. The bread was a hard, low-grade iron ore, called taconite. It was a big loaf, about 110 miles long, three miles wide and 500 feet deep. So for fifty years, nobody bothered with the bread. They just dug out the raisins.

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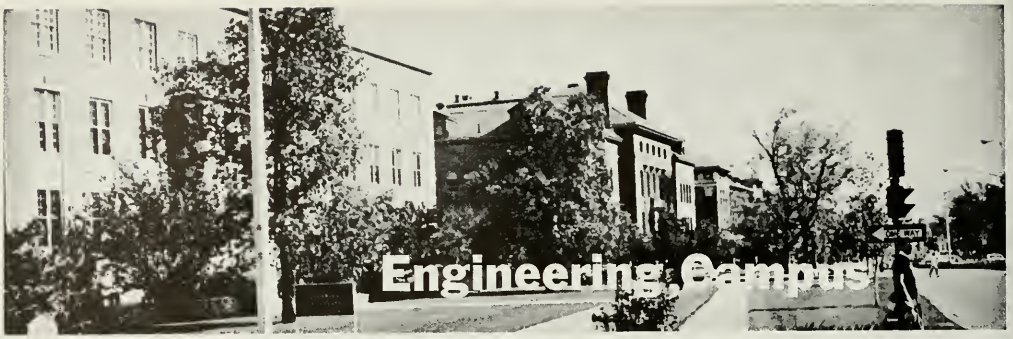

U of I PROFESSOR VISITS SCIENCE CENTERS IN RUSSIA

by Gary Sobol

From September 4th through 16th, Dr. Holonyak, a professor and leading researcher at the University of Illinois, presented seminars and visited laboratories in the U.S.S.R. Dr. Holonyak was invited to Russia by the Russian Academy of Sciences, all expenses incurred in Russia being paid by the Russian Academy. Funds for travel to and from the U.S.S.R. were supplied by the National Science Foundation.

Dr. Holonyak points to a tiny phosphide laser which he built.

Born in Zeigler, Ill., Dr. Holonyak received his B.S. in Electrical Engineering in 1950, his M.S. in 1951, and his Ph.D. in 1954, from the University of Illinois. Before being inducted into the Army, he spent a year at Bell Telephone Laboratories, where he held a position in the transistor development department. In 1957 he joined the Advanced Semiconductor Laboratory of the General Electric Company after which he came back to the U of I.

Dr. Holonyak's main area of interest is the solid state field, specifically semiconductors. For the past 15 years he has been involved in research in semiconductors and most recently has conducted research in this field with graduate students at the U. of I.

Dr. Holonyak is co-author of a book entitled, *Semiconductor Controlled Rectifiers,* published in 1964; and is the editor of the Prentice-Hall series of books entitled, *Series in Solid State Physical Electronics.* There are now six books in this series with several more being readied for publication.

During his visit to Russia, Dr. Holonyak presented seminars at the Lebedev Institute in Moscow, the Physico-Technical Institute in Leningrad and the Institute for Semiconductors in Kiev. All three of his lectures concerned research work on semiconductors here at the U of I. In addition to visiting the laboratories of these three institutes, he also visited the laser laboratory of Academician Basov, a Nobel prize winner for his contributions to laser theory and application.

Dr. Holonyak observed that the laboratories as well as the people who worked in them were very much like the labs and the people here in the U.S. He found that there were many young people working in the labs with definitely more professionally trained women than are found in laboratories of a comparable type here in the U.S. The laboratories were part of the Academy of Sciences and not part of any university. The only university students found in the laboratories were those working on their doctorate theses. The Russian laboratory equipment was not as elaborate as ours. Dr. Holonyak mentioned that the equipment looked, to some

extent, "home made". However he quickly added that though their equipment was perhaps not as lavish as ours, it was definitely adequate. Overall Dr. Holonyak found that in many areas of semiconductor research, the Russians are just as advanced as we are in the U.S. He found their theoretical thinking to be very good, and only in experimental work are we still a little ahead.

Dr. Holonyak looks over an apparatus he uses in the experimental investigation of semiconductor lasers.

When he was not speaking in one of his three seminars or visiting the laboratories, Dr. Holonyak took in many of the sights of Moscow, Leningrad, and Kiev. He found that he liked the sights of Leningrad best. He said that the people were extremely friendly and not too hard to talk to, since Dr. Holonyak speaks some Russian. By the end of his two week visit, he could converse fairly well. In each of his lectures he began by speaking a few sentences in Russian. This, plus the help he gave the translator in translating some of his lecture into Russian, always brought a big smile from the audience.

Because the Russians had translated the book written by Dr. Holonyak and his co-authors, he received some rubles in royalties. However, rubles are not allowed to be taken out of the U.S.S.R., and since the Russian Academy paid for all his expenses, Dr. Holonyak decided to leave his money in a Russian bank for later use. One of the Russians jokingly commented on this action by saying that Dr. Holonyak was a capitalist in the U.S.A. and now a capitalist in the U.S.S.R.

Though this was not Dr. Holonyak's first opportunity to give a seminar in a foreign land — while serving in the Army in Japan he gave a number of lectures — it was one of his most exciting experiences. Not everyone has such an opportunity to travel to the U.S.S.R.

LAS & BUSINESS COURSES: ARE THEY REALLY IMPORTANT TO THE ENGINEER?

by Gary Slutsky

What opportunities in industry will you have when you graduate? How important is having an advanced degree considered? Are liberal arts courses really necessary, or are they just a waste of time? A group of speakers from the college, industry, and government discussed these and other questions before a group of about three hundred engineering students at the first annual Engineering College Conference Combined Societies Meeting, October 10, at the Illini Union. The theme of the discussion was "Will Industry Want Me?" A question and answer session followed the speeches.

D. F. Waggoner, Director of Salaried Personnel Placement for General Motors, explained the roles of co-operative and training programs in industry. He stated that training was not to be treated as beneath the status of a college graduate but as a tool to help him do his job better. Training is essential to the understanding of how your job affects other areas of the manufacturing operation, and other phases of the business. "Industry wants a person who is a specialist, but who thinks like a generalist," he said. Waggoner warned against the "management attitude," personified by the young man with the masters degree in Business Administration who wants to be in charge of engineers before he has had any practical engineering experience.

Diametrically opposed views were presented on the necessity of the engineer having an LAS background as well as knowledge of engineering. Speaking against the necessity of engineers taking LAS courses was H. E. D'Orazio, Illinois Bell Telephone. Mr. D'Orazio defined an engineering education as all engineering work (mathematics, computer science, technical subjects) and

D. F. Waggoner speaking with two students after the panel discussion.

no liberal arts and sciences courses. The man who pursues this course of study was defined as a competent engineer, an "engineering practitioner." He went on to say that success is based on opportunity which is determined by industry's demands, that industry wants the "engineering practitioner" he had defined, and that a person's academic background must enable him to fit the largest number of available jobs. "In most cases today," he concluded, "the successful management career is one that follows the engineering route."

Hal D'Orazio (center) discusses with Dean Everitt points of a practical engineering education as Prof. Dobrovolny and Marv Smoller look on.

Mr. H. W. Turner, sales manager in the Instrumentation Department at Heath Company, eloquently presented the case for taking LAS courses along with one's technical courses. Mr. Turner said, "How liberal your education is depends on where you are going." He stated that if one is going to do purely technical work one doesn't need LAS, but such a person is highly expendable; technology advances and makes him obsolete. Mr. Turner stressed the fact that an LAS background makes one a better communicator. He is comfortable socially and professionally (representing his company at conferences and public speaking engagements) when dealing with people. He is more able than is his counterpart without an LAS background to let others know what a job is and what must be done. The engineer who is a good manager is the one with a liberal education.

Mrs. Pauline Chapman, director of the College Placement Office, stressed the importance of attitude. She said, "It's not what education you have, but what you do with it when you get out of school that makes the difference." She warned, as Mr. Waggoner had before, about wanting to manage too soon after obtaining a position. She then outlined what attitudes the young engineer should have to get ahead in industry.

Professor R. A. Jewett of the Department of General Engineering gave a short speech on the roles of the professional engineering societies. All engineering students were encouraged to join a student society in their particular field of study to gain further insight into the expectations of industry.

"There goes Melvin again — always trying to avoid the draft!"

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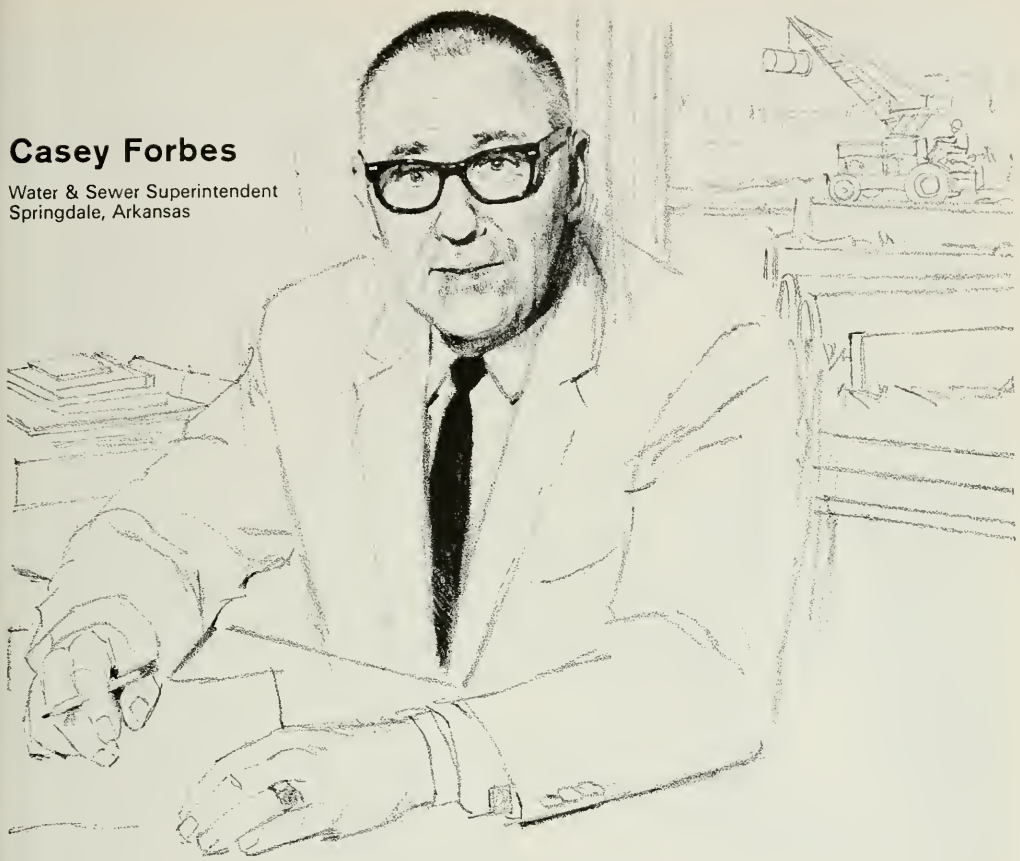

Casey Forbes

Water & Sewer Superintendent
Springdale, Arkansas

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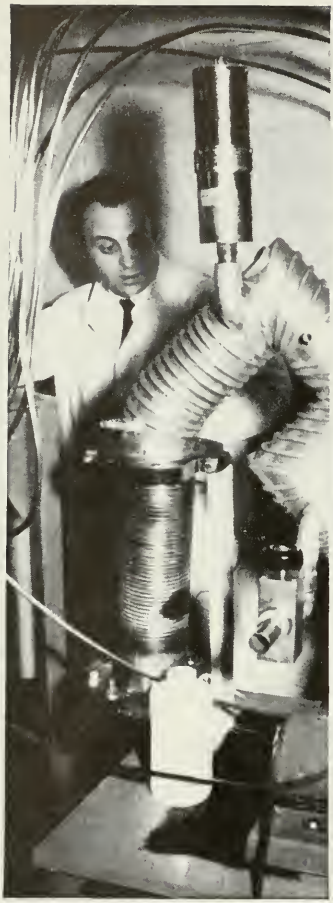

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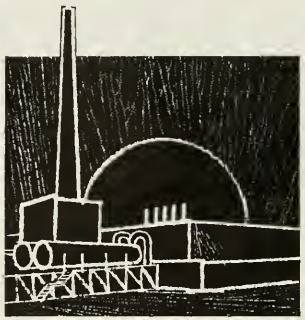

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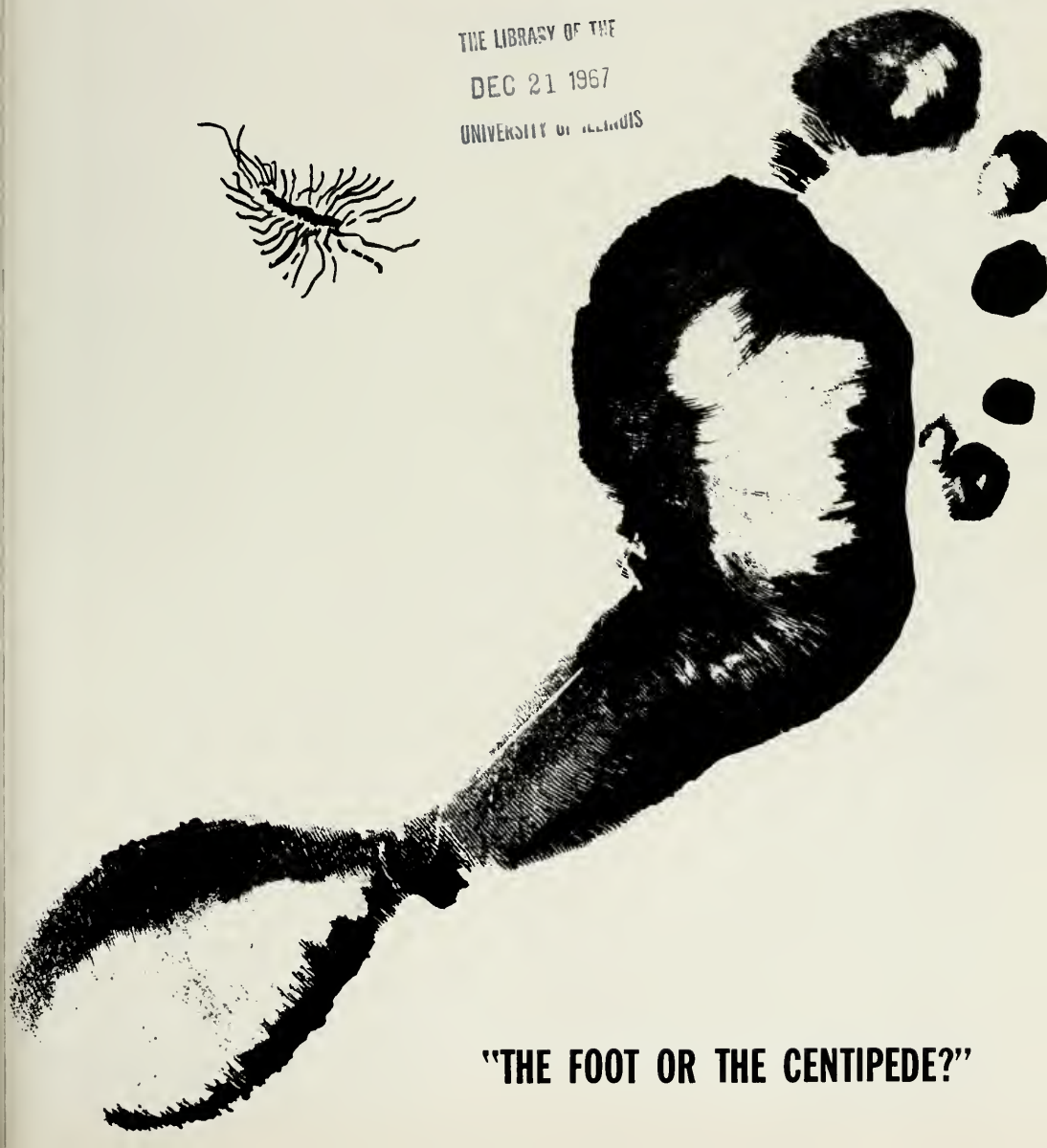

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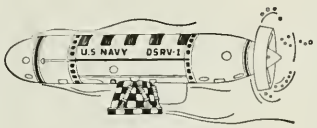

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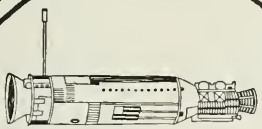

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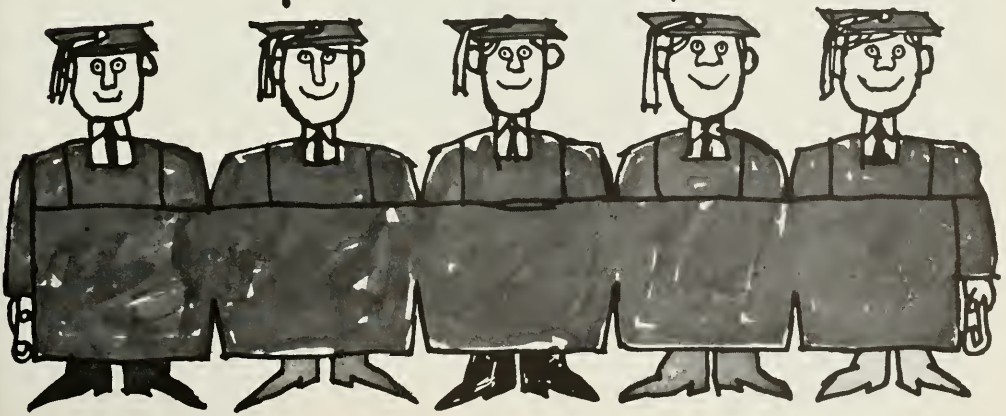

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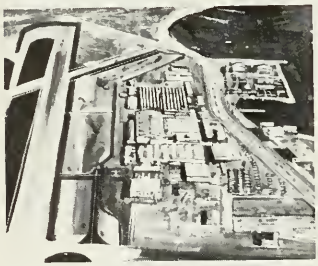

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editorial

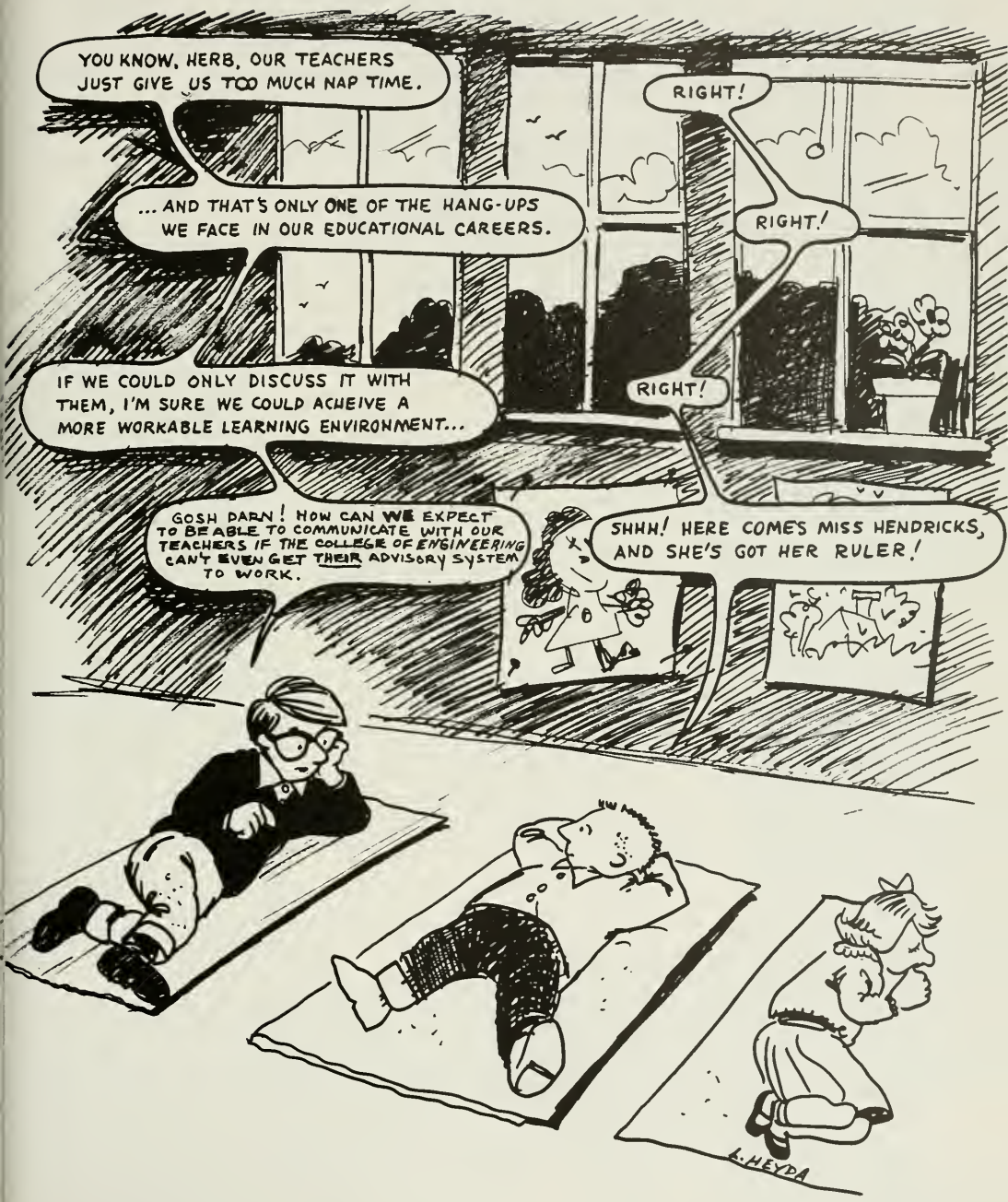
As one begins asking students and faculty what they think of our advising programs, it quickly becomes apparent that few are satisfied. Certain faculty feel the problem is that students do not have sufficient initiative to help themselves by consulting their advisors more often. In the words of Professor Edward Ernst of the E. E. Department in a letter to Technograph last spring, "We need to communicate to our students that if they utilize the services of their advisor, they will be able to enjoy a more rewarding educational experience." To many students such an invitation appears shallow. Advising often seems to be confined to preregistration periods and has come to mean instructions on how to fill out their # 2 IBM card.

Several advisors have given students the impression that advising is really a burden placed upon them by their department, and unless the student has a really serious problem, they would appreciate not being bothered. Ideally, advisors and advisees should meet even when students do not have overwhelming problems.

It was quite discouraging to find that with all the college-wide committees in Engineering, we do not have a committee to study the tremendous problems of advising. Surely, some departments do have groups that occasionally measure the success of their advising programs, but student dissatisfaction implies they have failed. It is time for the College's administration, rather than the individual departments, to take a long hard look into this issue.

Technograph strongly recommends that the College appoint someone to investigate all aspects of our advisory system. Furthermore, it is our feeling that for such an effort to be most effective, the person appointed to head the inquiry should be someone not presently connected with the College. We think he must be a person who can be entirely objective and who will not hesitate to issue criticism when and where it is needed. Right now the College of Engineering at The Ohio State University has a graduate psychology student working on their advising problems. If our College could find a similar individual who has some understanding of the particular problems associated with undergraduate education, we would have our man.

The students who have been discussing this problem are impatient. They would like to see the advisory system overhauled as quickly as possible, either through the institution of the above proposal or the implementation of a better one from the Dean's Office.


YOU KNOW, HERB, OUR TEACHERS JUST GIVE US TOO MUCH NAP TIME.
... AND THAT'S ONLY ONE OF THE HANG-UPS WE FACE IN OUR EDUCATIONAL CAREERS.
IF WE COULD ONLY DISCUSS IT WITH THEM, I'M SURE WE COULD ACHEIVE A MORE WORKABLE LEARNING ENVIRONMENT...
GOSH DARN! HOW CAN WE EXPECT TO BE ABLE TO COMMUNICATE WITH OUR TEACHERS IF THE COLLEGE OF ENGINEERING CAN'T EVEN GET THEIR ADVISORY SYSTEM TO WORK.
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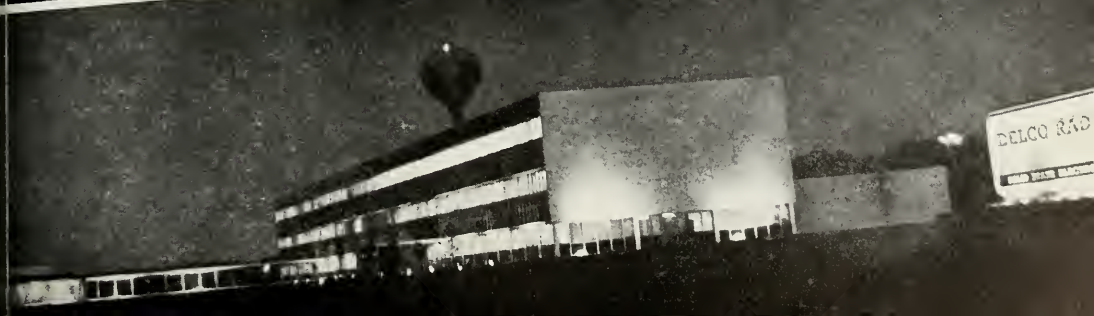

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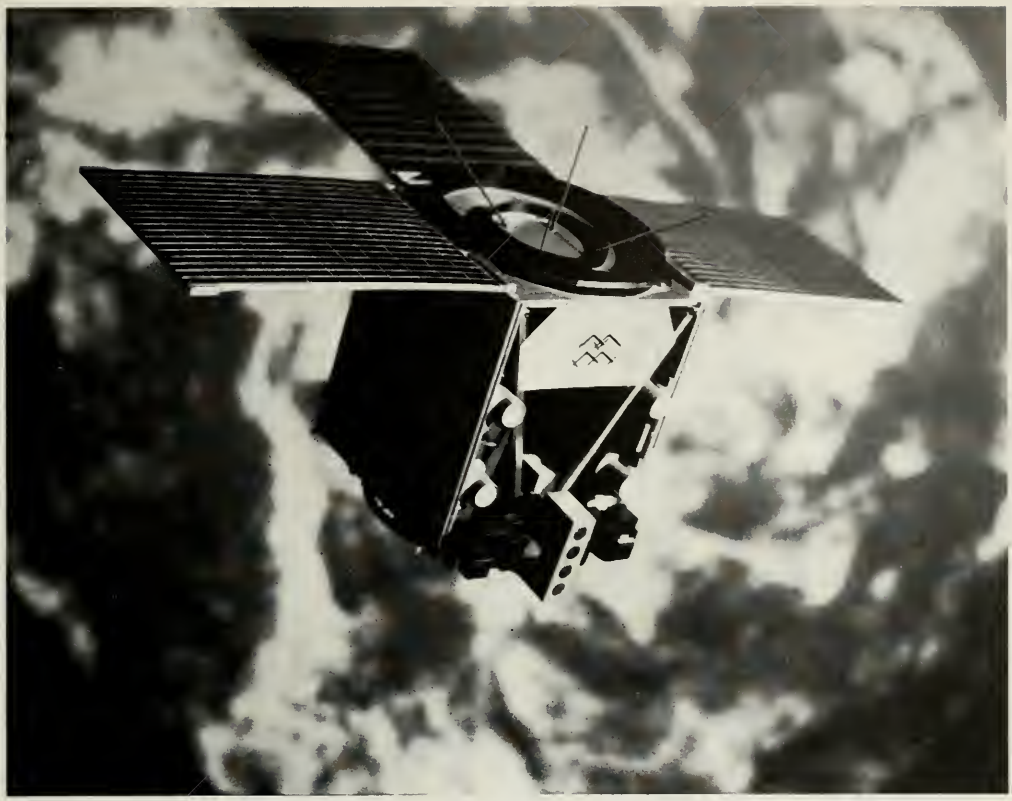

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CHRISTIANITY vs. SCIENCE

Part 1.

MIRACLES

MODERN SCIENCE AND CHRISTIAN BELIEFS

I. Miracles

This article is the first of a series by Jim Moore discussing the relationship between modern science and religion.

One invariably jars the emotional status quo of a scientific or religious community when discussing the traditional warfare between science and theology. 1 Whether you are disinterested or doctrinaire, permit me therefore to engender a bit of controversy by presenting the front line action in what has been an intriguing and variegated battle of wits between secular scientists and Christian theologians. This month I wish to discuss the conflict over the miraculous element in Christianity. [2] The point in dispute can be put in six Anglo-Saxon syllables: Can miracles occur? Later, the implications of the answer to this question will be explored.

It is best initially to consider several examples of antisupernatural argument. James Harvey Johnson of the Thinkers Club begins the polemic.

> **Religious beliefs are against common sense. There is no god, just because priests say so. There are no angels, devils, heavens, hells, ghosts, witches, nor miracles. These superstitious beliefs are promoted for the purpose of making the gullible believe that by paying money to the priest class they will be favored by one of the gods. There is nothing supernatural — nothing contrary to natural law.** [3]

If you are even slightly perceptive you have already determined that the title of Johnson's organization is a misnomer. Common sense arguments carry no philosophical-scientific weight in that they are wholly uncritical. Moreover his crass indictment of organized religion reveals his baleful ignorance of historic religious convictions and the psychology of religious belief. Hence we turn to fairer intellectual climes in the writing of A. J. Carlson, Nobel prize-winning geneticist and humanist pamphleteer.

> **By supernatural we understand information, theories, beliefs and practices claiming origins other than verifiable experience and thinking, or events contrary to known processes in nature, ... contrary to facts now known, or rendered untenable, as possibilities, by known facts... science and miracles are incompatible.** [4]

This is indeed a plausible statement by a famous scientist. It merits consideration together with the view of eminent New Testament scholar, Rudolf Bultmann.

> The whole conception of the world which is presupposed in the preaching of Jesus as in the New Testament generally is mythological;... the conception of the intervention of supernatural powers in the course of events; and the conception of miracles,... This conception of the world we call mythological because it is different from the conception of the world which has been formed and developed by science... modern science does not believe that the course of nature can be interrupted or, so to speak, perforated by supernatural powers. [5]

Here, surprisingly enough, we find a humanist and a Christian in agreement on an issue so often in debate between their respective schools of thought. However Bultmann does not hold the historic Christian conviction regarding miracles and consequently we should expect this concurrence. (The fact that Bultmannian views have become popular in contemporary theology may account for a recent de-escalation in the warfare of science with Christian theology.)

Together with the simple pejorative and influentially eminent views on the miraculous we must also consider David Hume's classic philosophical argument which constitutes the backbone of most arguments against miracles.

> A miracle is a violation of the laws of nature; and as a firm and unalterable experience has established these laws, the proof against a miracle, from the very nature of the fact, is as entire as any argument from experience can possibly be imagined... Nothing is esteemed a miracle if it ever happens in the common course of nature. It is no miracle that a man, seemingly in good health, should die on a sudden;... But it is a miracle that a dead man should come to life; because that has never been observed in any age or country. There must, therefore, be a uniform experience against every miraculous event, otherwise the event would not merit that appellation. [6]

Finally we have a succinct, unequivocal repudiation of miracles which combines the preceding views and lends them the intellectual weight of a renowned philosopher and analyst.

What have we discovered in these statements? We have learned that nothing occurs contrary to the "known processes." the "course," or the "laws" of nature because "firm and unalterable experience has established these laws." That is, an immutable *a priori* causal scheme has delimited the phenomena of the universe by barring events which have never been observed to happen. In fact, according to Hume (whose argument we may take as representative), a miracle is any event which does not occur!

Is there a cogent reply to this position? C. S. Lewis offers us one example.

> Now of course we must agree with Hume that if there is absolutely "uniform experience" against miracles, if in other words they have never happened, why then they never have. Unfortunately, we know the experience against them to be uniform only if we know that all the reports of them are false. And we can know all the reports of them to be false only if we know already that miracles have never occurred. In fact, we are arguing in a circle. [7]

Alternatively it must be observed that the assumption of a rigid system of natural law is tantamount to denying the possibility of miracles. Indeed, Hume tacitly assumed what he attempted to prove.

So much for circularity. The argument cannot be informative but may we not admit the existence of an immutable system of natural-law?

Men of the Newtonian epoch viewed the universe as a closed playing field in which scientists knew all the rules. Natural law was seen to be a structure latent in the universe which was being progressively uncovered. When exposed and mathematically formulated, this law allegedly enabled scientists and philosophers to *prescribe* what could and what could not happen. [8] "For, once the main reasoning of classical physics had been accepted as the *a priori* of physical investigations, the belief arose, through an obvious though false extrapolation that it was absolute, i.e. valid for all time, and could never be modified as a result of new experiences." [9]

"God is dead... He just enrolled in Engineering..."

However with the advent of the Einsteinian era scientists were confronted with the vicissitudes of so-called natural law in an uncharted and unobstructed universe. J. W. Sullivan makes this point *in extenso* in his book, *The Limitations of Science.*

> **What is called the modern "revolution in science" consists in the fact that the Newtonian outlook which dominated the scientific world for nearly two hundred years, has been found insufficient. It is in process of being replaced by a different outlook, and, although the reconstruction is by no means complete, it is already apparent that the philosophical implications of the new outlook are very different from those of the old one.** [10]

Today scientists admit that no one knows enough about "natural law" to say that any event is necessarily a violation of it. They agree that an individual's non-statistical sample of time and space is hardly sufficient ground on which to base immutable generalizations concerning the nature of the entire universe. Today, what we commonly term "natural law" is in reality our *inductive descriptions of natural phenomena.* These theories of varying certainty must continually be brought before the bar of the facts which they are alleged to describe. [11]

Can miracles occur? The key to the answer is the very experience which Hume (falsely) maintained was uniform and absolute. There is no *a priori* method of determining whether miracles have occurred. Rather, the way to determine that *anything* happens is to investigate specific, alleged events in their own right. Observation is of the essence of scientific method and the collective experiences and investigations of mankind must be decisive both in validating scientific theories and in verifying the occurrence of miracles.

Certainly miracles *could* (and may) occur if they *have* occurred. Determining whether miracles have occurred is the duty of historical investigation rather than philosophical speculation.

FOOTNOTES

1 Detailed information is available in A. D. White's monumental work, **A History of the Warfare of Science with Theology.** 2 volumes. New York: Dover Publications, Inc., 1960.

2 It would be impossible here to consider the question of the miraculous in all religions and cults. However the principles to be set forth are general and apply to all miracle claims. For a thorough treatment of alleged miracles throughout the history of Christianity, see Warfield's work **Miracles Yesterday and Today** (formerly **Counterfeit Miracles**) Grand Rapids, Mich.: Wm. B. Eerdmans Pub. Co., 1965.

3 **"Religion Is a Gigantic Fraud"** published by The Thinkers Club, Box 2832, Dept. RG, San Diego 12, California.

4 **"Science and the Supernatural"** published by The American Humanist Association.

5 Rudolf Bultmann, **Jesus Christ and Mythology** (New York: Scribner's, 1958), p. 15.

6 David Hume, **An Enquiry Concerning Human Understanding** (LaSalle, Illinois: The Open Court Press, 1958), pp. 126-127. The remainder of Hume's argument should be carefully read. This quotation is sufficient to indicate his dubious premises.

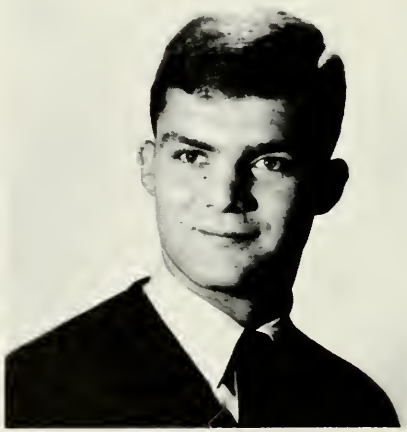
7 C. S. Lewis, **Miracles** (New York: MacMillian Paperbacks, 1947), p. 105.

8 Edwin A. Burtt, **The Metaphysical Foundations of Modern Science** (Garden City, New York: Doubleday Anchor Books, 1954), pp. 297-299.

9 Werner Heisenberg, **Philosophic Problems of Nuclear Science** (Greenwich, Conn.: Fawcett Premier Books, 1966), p. 24. This is an excerpt from a lecture originally published in **Naturwissenschaften** 1934, 22 Jahrg., Heft 40.

10 J. W. N. Sullivan, **The Limitations of Science** (New York: Mentor Books, 1963), p. 138. For an excellent, semi-technical survey of the implications of research in modern theoretical physics, see the published lectures given at Oxford University in Trinity Term 1958 and reprinted as **Turning Points in Physics** New York: Harper Torchbooks, 1961.

11 Max Black, **Critical Thinking** (Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1965), pp. 303-304.



Jim Moore is a senior in Electrical Engineering. He will attend Trinity Evangelical Divinity School, Deerfield, Illinois, in the fall of 1968.

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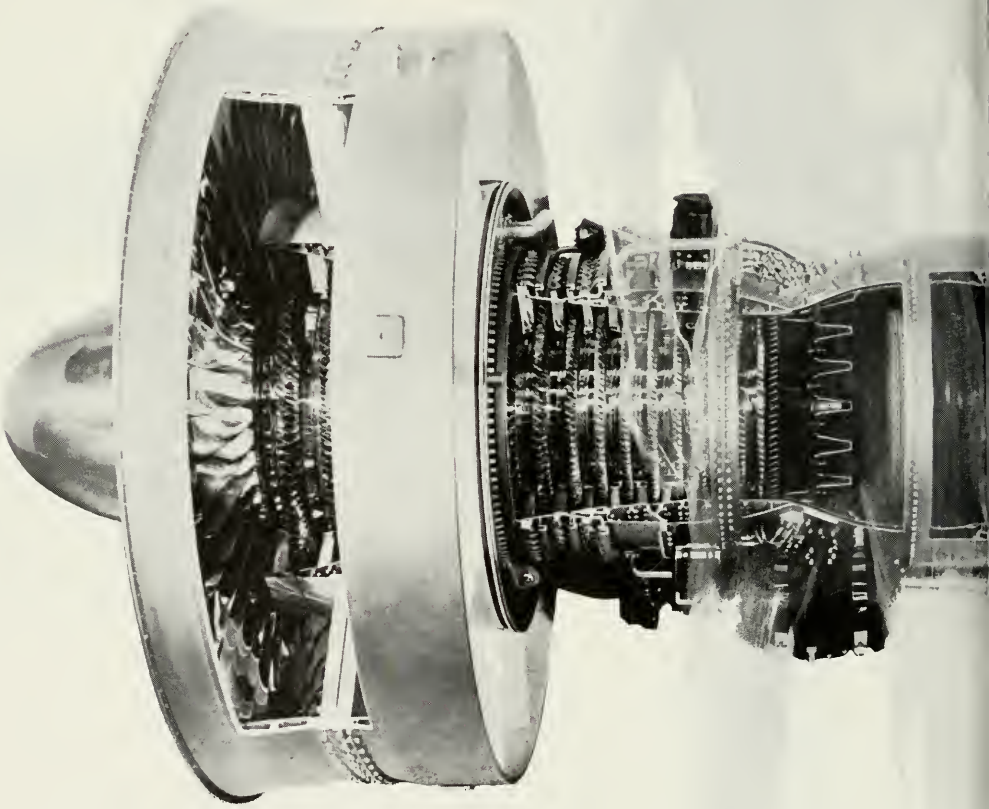

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MEASUREMENT and METRIC

by George Conway

George Conway is a sophomore in General Engineering. He is a member of Delta Phi Fraternity and is a member of the Illinois fencing team.

When the cave man crawled out into the sun, he looked at its position to tell the time of day. He measured something. Man has always been measuring the world around him. Today, man is not satisfied with the sun as the measure of time or a human thumb as the unit of length. He must have precise control over measurements if the industrial empire is to survive.

When man first started to build machines and construct buildings, he did not need elaborate standards to provide a workable sawmill or a wooden, one-room house. His buildings were crude and simple, and his tools and materials were rough and probably hand-produced. Now, things have changed; the measuring system no longer deals with the clearance of a water-wheel and its supports or a door and its frame. It must now calculate and produce the hairline fits between a gyroscope and its mountings. It must measure the exact second in which a planet is a minimum distance away from earth. The accuracy of every type of measurement, from foot to amperes, has increased and must continue increasing.

The need for this increased accuracy is a by-product of the complex interplay between industries and nations. In the past, different countries have had the same name for a unit although the units were not equivalent. Little confusion existed because most products were hand-made by one person, and he could regulate his own tolerances and control his own lengths however he fancied. Today, the process of mass production has put great demands on the measurement system of every nation. When several companies make parts for one machine they all must fit perfectly in order to have a working product. The space industry alone requires measuring devices of the utmost accuracy. The guiding rockets for the space craft must be fired with a specific thrust for a time which is measured in fractions of a second. Each one of these measurements requires countless previous ones with even closer limits.

Although it is almost unnoticed by people who have little connection with industry and commerce, measurement has been shown to be of great importance. Men who must produce and design the complex machinery, buildings, and bridges in modern society must recognize this importance. Engineers are constantly plagued with tolerances and clearances. Chemists are worried over weights and times of reactions. Physicists are concerned with forces and sensitive electrical apparatus. Businessmen are seeking the most profit with the best quality. All of these designs and problems depend on measurements.

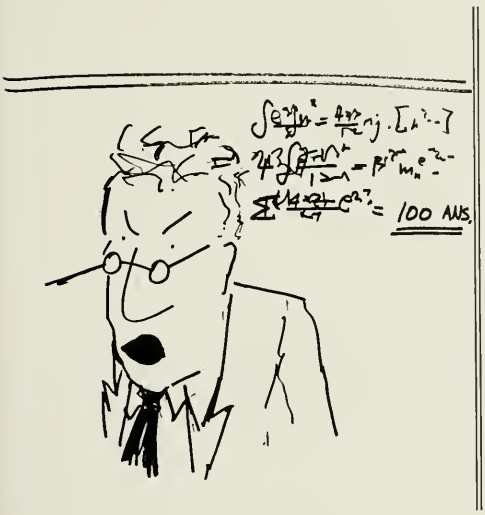
Recognizing that measurements are a necessary part of an industrial society, who determines the standards of measurement? The usefulness of national and international standards bureaus becomes apparent. The agency which American businessmen and industrial leaders are most interested in is the National Bureau of Standards. This Federal agency is not so much concerned with regulation of which system a business uses as it is concerned with the accuracy of the standards of that system. The Bureau's main function is to see that the standardization system of the nation is performing what it was set up to do, that is, helping the American industrial community. In serving the measuring needs of industry and research, it provides them with actual instruments or with the means of producing instruments which will provide accurate measurements. To insure that standards are complied with, the Bureau also checks products to see if they meet specifications.

Along with the calibration of industrial standards to national standards, the Bureau is constantly striving to provide better standards of its own. Such better standards are affected less by temperature, humidity, and other factors than the older ones. The platinum bar was an

excellent length standard for its time, but lengths a thousand times more accurate now are needed for day-to-day activities. The new length standard is the wave length of the krypton-86 lamp kept at 346 degrees below zero. The significance of the lamp is that firms can produce their own apparatus for setting up their own length measurements. This provides quicker, more efficient use of industries' time and money and insures an accurate product. Other reproducible standards, such as the cesium clock, are also available to those who wish to use them. Although such devices require minor periodic checks, they enable research and development to be self-reliant in conforming to a national standard.

The National Bureau of Standards provides the nation with a common set of standards for every type of measuring. Research could not progress nearly as fast if the standards it used were not uniform and accurate. Industry would find parts that did not fit or machines that would not work if it were not for a set of standards. Even though the National Bureau of Standards does not produce anything, research and industry could not survive without it.

The National Bureau of Standards works well for the United States, but it is only part of the international system of measurement control. The recognized international authority on weights and measures is the International Organization of Weights and Measures. This organization has the power to define the units of measurements and to supervise the standardization of these measurements. The organization, founded in Paris in 1875, recognizes only the metric system. However, the United States is a member of the International Organization because in 1893 the United States began defining its measurements in terms of the metric system.



"No Jones, a 'silly millimeter' longer is not *right!"*

Another standardization agency is the International Organization for Standardization (ISO). Its primary purpose is to promote the development of industrial, commercial, engineering, and safety standards. There are fifty-one nations, including the United States, in the ISO. The organization mainly examines and proposes new standards for member nations. The nations are in no way bound to the directives of the ISO but its recommendations are given much attention.

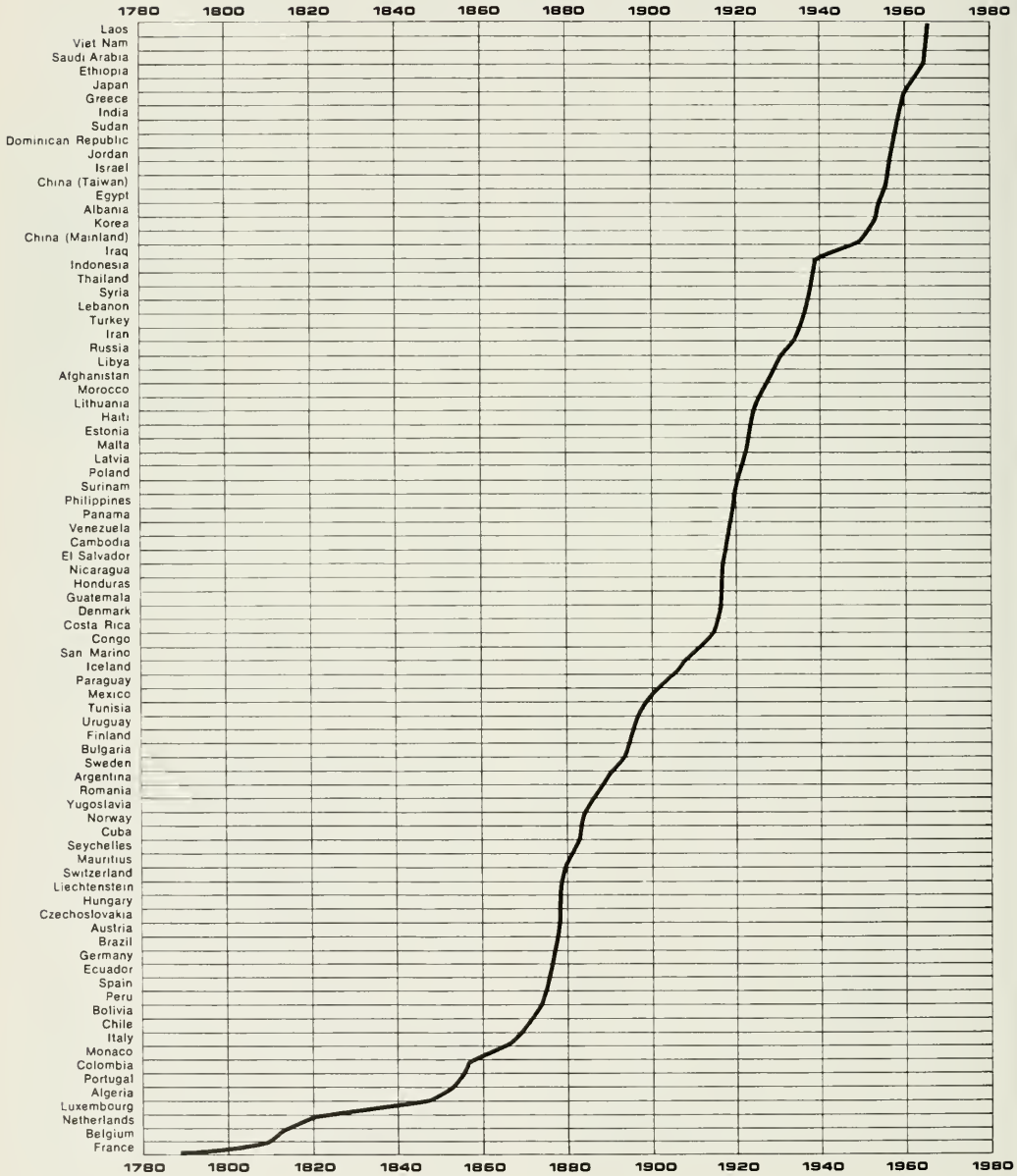
As one looks at these international organizations, it soon becomes evident that the basic measuring system is the metric system. Even the countries that are not on the metric system define their units in terms of metric units. One may wonder why the metric system is becoming the dominant measuring system or if it is really that much better.

Indeed these questions are difficult to answer. One system is probably no better than another as long as it can be applied to the situation. But, there are some advantages which, while they are not of the greatest importance, do make the metric system easier to handle. Since the United States uses decimal numbering, it seems foolish not to have its measuring system decimalized. It is also much easier to compare length, volume, and weight when they have a direct relationship to each other as in the metric system. Finally, and most important, the basic unit of length of the metric system is taken from an unchanging physical standard, the earth.

Since the founding of the metric system in 1791, eighty-two nations have adopted it. The table shows the countries using the metric system and when they adopted it. It is apparent that the system was not accepted by many people until almost one hundred years after it was conceived. Nevertheless, most of the major nations in the world now use the metric system. The only two big countries that do not are the United States and Great Britain, and that situation is being changed.

1975 is the English target date for complete changeover to the metric system. However, little action has been taken by the English yet. When the change in systems comes, manufacturing and commercial industries will be most affected. Consequently, industry is leading the small progress which is being made. Industry is giving its operators charts which use both the metric and English standards to familiarize them with the units. The construction industry is slowly changing its

THE 82 NATIONS OF THE WORLD THAT HAVE ADOPTED THE METRIC SYSTEM



plans and specifications to the metric system. Education of the people about the metric system must also be carried to the schools. The problem is that textbooks have yet to be revised. One of the big problems will be with fasteners and threads. Industry must either change the sizes of the threads and fasteners or use the same ones with odd metric sizes. No one looks forward to either prospect.

As yet, England has not passed any laws declaring when the use of the metric system will be mandatory. Without these and other laws regulating the use of the metric system, the change-over may take much longer than the 1975 target date.

Someday the entire world will be on one system. International trade will be conducted much more efficiently, and research will be more easily transmitted from one country to another. Industry will expand to better plant sites without fear of problems in double standards. The metric system will probably be the system because it does possess a few advantages, including the greatest popularity today.

The term measurement has many different meanings to different people. It may mean the size of a can of vegetables or the distance to the nearest town. It may also mean the clearance of a bridge or the balancing of a rocket in space. Every person has some connection with the measuring system, either through direct control or everyday use. Measuring systems are the mark of a civilization; the degree of accuracy and use of the system is a measure of the level of the society. Without measurement, the world of today with all its modern conveniences could never have been produced.

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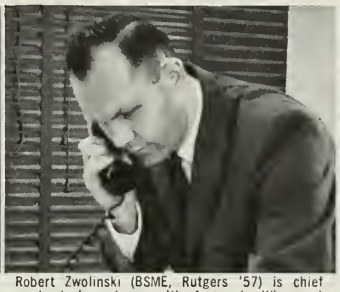

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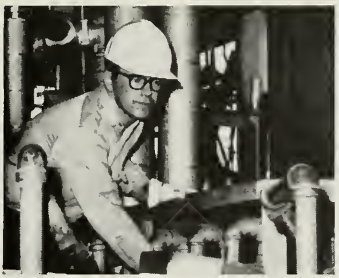
Robert Ingersoll (BS Geol., Montana Tech. '51 MS Geol., Montana Tech. '64) right, is senior geologist, Anaconda's mining operations, Butte, Mont.



Thomas Tone (BS Mining, U. of Arizona '62) is foreman of the furnace dept. at the electrolytic copper refinery in Perth Amboy, N.J.

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Jay Bonnar (BS Met., M.I.T. '57; MS Ind. Mgmt., M.I.T. '62) left, is research administrator of Anaconda American Brass Company's research and technical center, Waterbury, Conn.

Wilson McCurry (BSc, Arizona State '64) is an assistant geologist in Anaconda's new mines dept., currently working on development of the Twin Buttes mine near Tucson, Ariz.

Terrence McNulty (BS Chem., Stanford '61; MS Metal., Montana Tech. '63; DSc Metal., Col. School of Mines '66) is senior research engineer, extractive metallurgical research, Tucson, Ariz.

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ENGINEERING

Today's engineers are beginning to realize that there is a new dimension to engineering problems. Gordon Brown, Dean of the School of Engineering at M.I.T. defines "Doing Engineering" as "practicing the art of the organized forcing of technological change." [1] Now more and more engineers are beginning to consider the effect changes are having on society. William Linvill, Head of the Department of Engineering Economic Systems at Stanford University remarked at the CSL dedication, "The technological changes ahead are so vast and their consequences are so drastic that chaos is likely to result unless some systematic coordination is achieved." [2] The engineer of the new dimension is realizing that it is becoming his responsibility as a professional to guide technological change and, equally as important, the consequences of this change. "The Engineer-Manager may eventually surpass the professional politician to determining the destiny of the world," predicts Chauncy Star, the new dean of UCLA's College of Engineering.

Mickey Mindock is a senior in Engineering Physics from Kankakee, Illinois. Last year he served as President of Engineering Council.

What are the changes that will be affecting the future of man? W. L. Everitt, Dean of the College of Engineering at the University of Illinois has summarized them into two general challenges to the engineer: [3]

1. The Challenge of the Knowledge Explosion
2. The Challenge of the Population Explosion

When we realize that "90% of all scientists who ever lived are living now; * the amount of technical information available doubles every ten years; throughout the world about 100,000 journals are published in more than 60 languages, and the number doubles every 15 years" [4] we can see the tremendous challenges of the knowledge explosion.

One way that Everitt mentions to control this explosion is through interdisciplinary cooperation. "While the education of engineers must provide depth so that they may contribute, it must also provide breadth so they may communicate. We need to develop meaningful communication between engineers and other educated people, so we may understand them, and they may understand us."

Not only does the knowledge explosion encompass the knowledge of the solutions to problems but also the knowledge that there are many more problems to be solved. Today we are faced with deciding which problems are the most important to solve in order to guide society into the future. Dr. Glen Seaborg, Chairman of the Atomic Energy Commission tells an interesting anecdote that illustrates the challenge of "The Importance of the Relevant." A little boy was taken by his father to the zoo for the first time. "When they visited the lion house, the father went into some detail on just how ferocious a beast the lion was. Following a rather vivid description of what the lion might do if he escaped from his cage, he concluded, 'And if that lion should get out of his cage he would not only tear me all apart, he would also eat me all up.' Then he asked the terrified youngster if he had any questions. The little boy did. 'Daddy,' he said, 'if that bad lion should get out of his cage, tear you all apart and eat you all up, what bus should I take home?'" [5]

We are probably more familiar with the "Challenges of the Population Explosion." Among these Dean Everitt emphasizes need for an adequate food supply. He stated that "our surplus could change to scarcity, and even famine, as it has in many other parts of the world."

Another challenge of the population explosion is urbanization. James W. Rouse, builder of the sociologically engineered city of Columbia, Maryland, estimates that "We face the addition of 70,000,000 people to our cities over the next 20 years — a new Toledo each month... we convert over 1,000,000 acres of land each year from agricultural to urban use..." [6]

A NEW DIMENSION

Considering that there are limited sources of energy available from fossil fuels we are confronted with deciding on the "Optimum Use of Resources." Closely allied with the challenge of using the resources of nature are the problems of using the resources of man. Engineers will need to consider the welfare of those workers whose jobs are overtaken by automation or technological change.

How are the engineers of the new dimension meeting these challenges and what methods are they using to solve them? The organized beginnings to solving these problems take formal root in the establishment of the National Academy of Engineering.

Before looking at the NAE let us consider its history and, in particular, the history of its father organization, the National Academy of Science. The NAS, whose purpose is to encourage research and the diffusion of scientific knowledge and to advise the federal government on matters of science and technology, was founded during the Civil War when Abraham Lincoln was President. The NAS got off to a slow start mainly because the United States was not deeply concerned with science. During World War I things began to change. The United States was faced with the problem of the technical preparation of the armed forces and also the need to develop technical products formerly coming from Europe whose supply had been cut because of the war. President Woodrow Wilson turned to the National Academy of Science for advice. Stimulated by this, the Academy formed within its organization the National Research Council, consisting of representatives of leading scientific and technical societies, for the purpose of advising the government. The functions of the NRC included the stimulation of research in the sciences and the application of science with particular emphasis on military and industrial problems connected with the national defense.

It was another war, World War II, and the need for weapons research that focused part of the attention of the government back on engineering. Many scientists stepped out of their usual roles and became systems engineers or managers which led to the development of the atomic bomb and radar. Many new government-sponsored laboratories were created during this period including the radiation labs at M.I.T. and Berkeley, and the AEC labs at Oak Ridge and Los Alamos.

After World War II the great emphasis on science and technology remained. A technological race arose between the Soviet Union and the United States exemplified by nuclear devices, space vehicles and now antiballistic missiles. The NAS greatly increased its influence on national policy during this period.

Some distinction must now be made between the scientist and the engineer. The prime role of science is in seeking knowledge and understanding it for its own sake, but as Dean Lawrence H. O'Neill of Columbia University said, "Engineering is not science... Engineering is a user of science, even a contributor of science; but its purpose is essentially different. That purpose is to apply scientific knowledge — in fact, knowledge of any kind — to make men's lives richer, safer, less burdernsome, happier." One of the founding committees of the NAE gives this definition, "The engineer solves problems by the application of science and technology, and where old technology is inadequate, he translates new scientific knowledge into new technology to create new systems and facilities."

"He wants to talk to a civil engineer about rebuilding his image!"

Keeping the distinction between the scientist and the engineer in mind it is easy to see why there arose a general dissatisfaction among the engineers with the NAS. The NAS was the main adviser to the government on problems of science and technology, and yet the NAS did not recognize proportionately the same number of engineers as scientists. The main division of the National Research Council was the engineering division which had to solicit advice from engineers who were not members of the NAS. In addition, engineers were becoming increasingly concerned about their public image and loss of prestige. They were becoming identified with other disciplines, and many were erroneously identified by the public as scientists.

For these reasons the idea of a National Academy of Engineering started to take root. In 1962 the Engineers Joint Council and the National Academy of Sciences held a joint committee meeting on the National Academy of Engineering. It was agreed that in the NAS the "affective organization and conditions of operation precluded effective participation of engineers in matters related to national technological programs and policies."

Committees were then established to study the pros and cons of a National Academy of Engineering including ways of organization and establishment. Finally, on December 5, 1964, the National Academy of Sciences adopted the articles of organization for the National Academy of Engineering. The new organization is independent and autonomous in its organization and the election of its members. It is closely coordinated with the National Academy of Sciences in its advisory activities.

In the spirit of cooperation that exists between engineer and scientist Dr. Kinzell, the new President of the NAE, and Dr. Sietz, President of the NAS, issued a joint statement declaring, "We look forward to a long and beneficial association which will serve the engineering community, the scientific community, and the nation as a whole."

The objects of the National Academy of Engineering are printed at the end of this article along with a list of some of the recent committees that have been formed. The first object of the NAE is, "To provide means of assessing the constantly changing needs of the nation and the technical resources that can and should be applied to them, to sponsor programs aimed at meeting these needs; and to encourage such engineering research as may be advisable in the national interest." This is the new dimension of engineering.

"Whole tribe save many moons to send you to place called Illinois. How come bridge you build fall down?"

OBJECTS OF THE NATIONAL ACADEMY OF ENGINEERING

To provide means of assessing the constantly changing needs of the nation and the technical resources that can and should be applied to them; to sponsor programs aimed at meeting these needs; and to encourage such engineering research as may be advisable in the national interest;

To explore means for promoting cooperation in engineering in the United States and abroad, with a view to securing concentration on problems significant to society and encouraging research and development aimed at meeting them;

To advise the Congress and the executive branch of the Government, whenever called upon by any department or agency thereof, on matters of national import pertinent to engineering;

To cooperate with the National Academy of Sciences on matters involving both science and engineering;

To serve the nation in other respects in connection with significant problems in engineering and technology; and

To recognize in an appropriate manner outstanding contributions to the nation by leading engineers.

SOME OF THE ACTIVITIES OF THE NATIONAL ACADEMY OF ENGINEERING

1. Committee on Public Engineering Policy

2. Ad Hoc Committee on Control of Wastes in Air, Water and the Land
3. Aeronautics and Space Engineering Board
4. Committee on Scientific and Technical Communication
5. Environmental Studies Board
6. Study of Science, Engineering and Regional Development
7. Committee on Ocean Engineering
8. Committee on Earthquake Engineering Research
9. Committee for the Development of Criteria for Non-Rail Transit Vehicles

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Ralph B. Peck	Professor of Foundation Engineering
Chester P. Siess	Professor of Civil Engineering

* Founding members

FOOTNOTES

1 Gordon Brown, "**Modern Education in Science and Engineering — Pace Setter of Industrial Technology,**" a presentation delivered at the 1964 Long Range Planning Conference Oct. 21-23, Palo Alto, California.

2 William Linvill, "**Man, Technology, and Society,**" a presentation given at the dedication of the Coordinated Science Lab Oct. 17, 1967, University of Illinois, Urbana, Ill.

3 W. L. Everitt, "**We are Being Challenged,**" presented at the dedication of the Engineering Center, University of Colorado, Boulder, Colorado, May 6, 1966.

4 Kaiser Aluminum News, Vol. 24, No. 1, p. 5.

5 Dr. Glenn T. Seaborg, **Science and Our Society**, United States Atomic Energy Commission Division of Technical Information, May, 1966, p. 34.

6 From statement of James W. Rouse, President Community Research and Development, Inc. before the Housing Sub-Committee, House Banking and Currency Committee on HR 12946, Title II, Land Development and New Communities, March 25, 1966.

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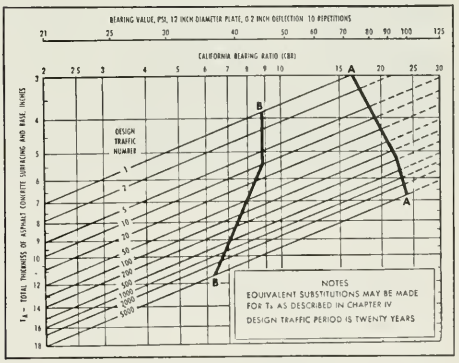

Thickness Design Charts like this (from the MS-1 manual) are used in this new computer-derived method. This chart enables the design engineer quickly to determine the over-all Asphalt pavement thickness required, based on projected traffic weight and known soil conditions.

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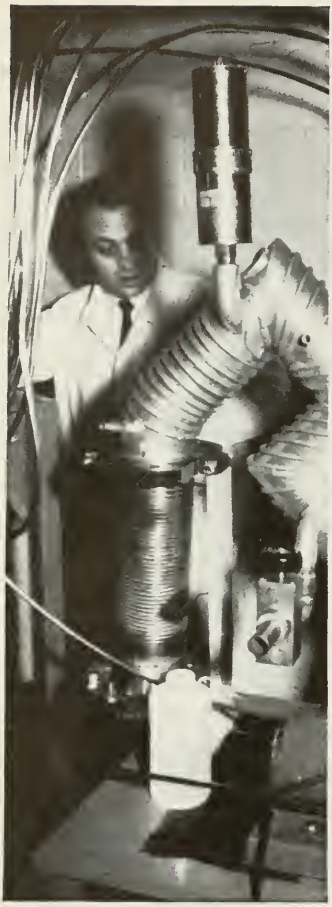

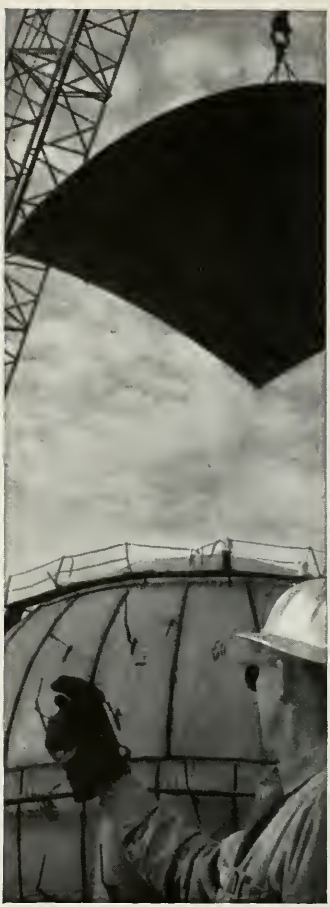

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G. E. OFFERS LAW COURSES

By Larry Dittmer

The practicing engineer has responsibilities to his society and to his employer. While many of these responsibilities are not spelled out in black and white, others are written laws, and the engineer should be aware of them.

The General Engineering department at Illinois offers survey courses in law covering patents, contracts and specifications, and a general course in engineering law. In order to better understand the content of these courses and their importance to the engineering student, I talked with Paul Karlstrom, who teaches the course in engineering law.

Paul Karlstrom is a successful attorney with fifteen years of experience in the general practice of law in Champaign. As an undergraduate he earned his way primarily by working as a jazz musician and presently is secretary of the Champaign Federation of Musicians.

I asked Mr. Karlstrom to describe the engineering law courses offered by the General Engineering department.

G. E. 292 is entitled Engineering Law and although it deals substantially with the law of contracts and the mechanics of contracting procedures, it is broadly law for the non-lawyer in any field who, before he goes out into this cold world in any profession or vocation, certainly needs to have something more than the layman's knowledge of law. This course is intended to give the student a general picture of the whole field of law; especially those subjects that would apply primarily to anyone in the field of business and industry, eliminating some of those areas which might be considered more social law.

G. E. 290 is somewhat more specialized in that it covers contracts and specifications, almost exclusively. We do not cover the area of specifications in the 292 course.

There is also a course (G. E. 282) which deals expressly with the law of patents and patent procedures.

What is an example of the type of problem that you discuss in 292?

I think the students who take the course often find interesting our discussion of the role of the expert witness in the course of a trial. Most practicing engineers sometime in their career are involved in acting as an expert witness in a trial matter. Many lawsuits are based on contracts or relationships that involve highly technical engineering terms. The trial of a law suit is fundamentally a presentation of factual evidence to a jury, and no layman can properly present a technical engineering matter without consulting with some expert. That's where the engineer comes in. He must educate the attorney on the technical matters involved in his lawsuit before trial. He is then important on the witness stand as the expert witness who explains technical matters, and renders opinions on technical questions. He is also essential during the entire course of the trial to consult with the lawyer from time to time, advising, for example, what questions might be asked the opposing expert witness in order to impeach his testimony. So, as I said, I believe the students taking the course find this discussion of the role of the expert interesting.

Larry Dittmer is a junior from Carthage, Illinois. He is studying Electrical Engineering and is a member of Marching Illini and College Young Republicans.

Are there many lawyers who have a background in engineering and who specialize in the combined fields?

With the current emphasis on the sciences, generally, I'm sure there will be many, many more. Of course there are many now. It has always been recognized that an engineering undergraduate degree is an excellent background for law, particularly for one who expects to work in the broad field of industrial law or, more specifically, in the field of patent law. Some of the seniors in my class I find are considering or definitely planning to go to law school. I think the engineering-law combination will become more and more common.

You can, of course, visualize the importance in a corporation of a lawyer who has an engineering background. The non-engineer lawyer, for instance, in drawing contracts for a corporation is certainly going to have to call in a specialist to give him the necessary terminology and technical language, whereas the lawyer with an engineering background is his own expert in this respect.

With respect to my course as it applies to engineers, I often start the course by telling the class that while they are in the course as senior engineers, it is the type of course that any individual, working toward a degree in any field might well have. I think that it is a shame that any college graduate does not have some business law course. We do not try to give the student enough knowledge to deal with his complicated legal problems, but enough knowledge so he recognizes, at least, when he does have a legal problem. By the time many legal problems are brought to a lawyer they are much more complex than they would be had they been promptly brought to his attention.

Don't most students expect to be pushing a slide rule and doing math problems when they get out of school?

Yes. I don't think they realize that as they move up the ladder they become more and more involved in the business world and assume more and more responsibility. This leads us to the interesting law of agency, or employee-employer relationships.

There is quite a difference between an employer-employee relationship and a principal-agent relationship. As you work in the relationship of an employee you owe a rather small degree of fidelity to your employer; there is no great position of trust and confidence existing between the two, as far as the law is concerned. But as this employee becomes, in the eyes of the law, an agent, then he assumes a much heavier legal responsibility to the principal.

Do you think that the engineering program here tends to smother the student with technical information and to leave him at loss as to the legal significance of what he is doing?

I believe this may be at least partially true. Certainly the graduating senior should have had a part of his course of study devoted to areas of broad concern, intended to equip him to use intelligently the great store of technical knowledge that he has acquired.

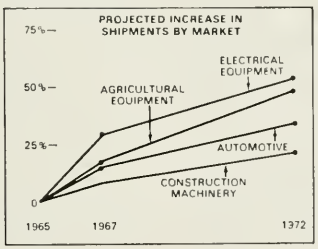
GROWING

One of the outstanding characteristics of the Malleable Castings Industry.

The Malleable iron industry began its growth in 1826 with the development of a unique cast material by a Yankee genius named Seth Boyden. Malleable was heralded by pre-Civil War America as the iron which "could be hammered and shaped without breaking." But in time, as markets changed and technologies advanced, the material made the transition from wagons and cannons to cars and rocket heads, upgrading its applications from simple structural parts to highly reliable mechanical components.

In 1965 and again in 1966, sales of Malleable castings were over 1.1 million tons, the best years in the industry's long history.

The chart at right shows the projected Malleable growth curve in its four major markets through 1972. These figures were developed after an extensive survey of industry customers, and indicate that Malleable will soon be a 1.4 million ton-a-year industry. And this growth is matched by increasing opportunities for technically trained people.



Currently, the average American new car uses 120 pounds of Malleable castings, some of which are shown above. Reading up, they include a connecting rod, bearing retainer, air conditioner clutch, joint yoke planet carrier, housing cover, non-slip differential case, and the calipers mounted on a disc brake.

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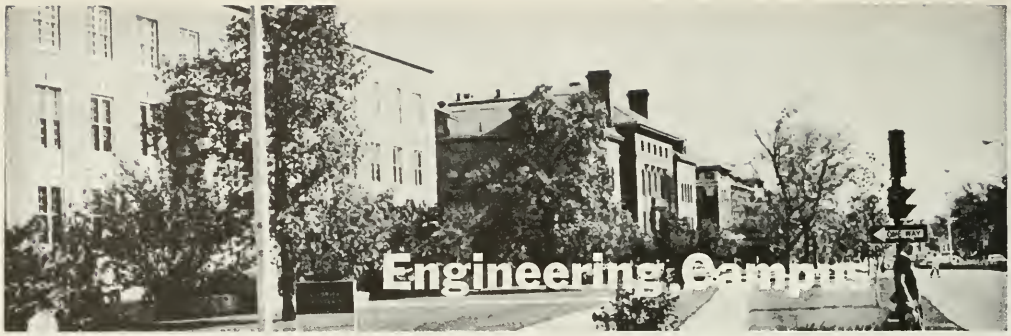

FEEDING THE FUTURE:

"Food and Engineering for a Changing World"

Dr. R. W. Stephenson, Head of the Process Engineering Research Department of General Mills, Inc., lectured in the auditorium October 26 on the food problems facing the world. His speech was one in a series (of University of Illinois Centennial Lectures) given as the Freshman Lecture Series for G.E. 100.

The world's food problem will be easy to define in the future, according to Dr. Stephenson. There is no simple way to produce all the food necessary in tomorrow's world. There will not be enough food to feed this world's mushrooming population unless some major advances occur soon in farming and processing technology, in food products-waste materials conservation and efficiency, and in the invention of totally new kinds of foods. For a satisfactory long range solution, major advances in all these areas must occur.

The problem in the United States is much less severe. This is because our technological advances have been outstanding. Less than 10% of America's population are farmers, whereas 40% to 60% of lesser developed nations' populations farm. In America food processing is BIG business — almost all foods produced in the United States are processed in some way. It is the largest industry in the U.S., accounting for over $100 billion each year. The problem in the United States actually is not that of growing enough food, but of producing the right (popular) kinds of food. America is becoming diet- and health-conscious, and convenience in foods is stressed, not to mention the fact that people here are particular in what they buy. We are eating better than ever before.

The United States is able to accommodate these changes and demands with the following technologies:

1) Freeze-drying. This is used for dehydrated food products. It is accomplished through the application of high vacuum and controlled temperature to produce sublimation.

2) Cryogenics. This low temperature processing is done with liquid nitrogen. It has some distinct advantages over mechanical refrigeration.

3) Aseptic Processes. "Sterilization" of foods can be done by high temperatures for short times. This maintains desirable qualities in the food, such as color, texture, and flavor.

4) Aglomerating Techniques. This involves drying a substance so as to give instant solubility.

5) Electrodyolosis. The removal of certain ions in solution in the food. For example, some acidic ions are removed from citrus fruits to sweeten them.

However, the rest of the world is not so lucky as the United States. They have relatively few machines and modern plants. It is estimated that the world's population will double by the year 2000. There is no way we and the other major developed nations can solve the problem — we have not enough potential to handle the problem, such as new land yet unopened to cultivation.

The speaker then noted two ways to look at solving the problem: a short range solution, good for approximately one generation, after which presumably the world will again be short of food; and a long range future development of totally new foods. This short-range solution is part direct and part indirect approach. We can increase the use of fertilizer and insecticides and farm mechanization. These are musts all over the world. Because of farm mechanization, for example, California rice growers are actually 270 times as efficient as Asian rice growers. The problem of food shortage can be alleviated indirectly by minimizing the population explosion; by educating farmers in new farming techniques; and by improving the sanitation and conservation of food, which means eliminating rats, obtaining (better) refrigeration and canning facilities.

The long range solution to food shortage must involve the introduction of totally new foods and nutrients. Already some new processes have been developed, including one called fiber spinning. Many synthetic fabric fibers are produced by this method. A mash is made from some forage crop with the necessary texture, usually soy beans. Extra proteins and chemicals are added, and the mash is brought to the proper viscosity. Then it is forced through the tiny holes of the spinnerets to become threadlike material. This substance, after coloring and flavor have been introduced, is then woven into whatever food product is desired to be synthesized — ham, frankfurters, scallops, chips for snacks, etc.

There are other areas of importance in the future development of new foods. Synthesis of nutriments and extraction of protein from petroleum and micro-organisms is being examined, as well as artificial photosynthesis. No discussion of food shortage and its solution can be complete without mention of the ocean. The ocean already is a major source of food, but its potential ability to feed the world is virtually untouched.

"I wouldn't be in engineering today if it had not been for my father... Damn him anyway."

DR. LAURITS BJERRUM GIVES DEDICATION DINNER ADDRESS

by Tom Brown

An appeal for the preservation of the art of civil engineering highlighted the recent Civil Engineering Building Dedication Dinner address given by Dr. Laurits Bjerrum. Dr. Bjerrum, Director of the Norwegian Geotechnical Institute and world renowned in the field of soil mechanics and foundation engineering, spoke about "Lessons for the Future from Failures of the Past."

The failures Dr. Bjerrum chose to speak about were not due to negligence but were failures of projects which were completed with the consultation of some of the world's outstanding engineers. The lessons to be learned from these failures indicate that more than conscientious application of standard and accepted engineering practice is sometimes needed to prevent failures.

One lesson these failures have taught Dr. Bjerrum is that details must be recognized. That is, a certain phenomenon may be an insignificant detail in most projects but a controlling factor in others.

The theory used to solve the practical problems of any project must also be critically evaluated. Dr. Bjerrum's example was a project in which the accepted theory of the problem was applied faultlessly. However, after a failure occurred, the consulting engineer refused to admit that the theory was incorrect. Lack of critical evaluation prevented the engineer from believing that the standard and accepted theory could be incorrect in this one case.

The limitations of the design used must be known. The simple fact that a given design has not failed in the past does not mean that this design considers every facet of the problem correctly. The design may be grossly incorrect, and yet prevailing conditions may have prevented a failure. The application of this design when these conditions are not present would lead to failure.

A fourth lesson to be learned is that the important properties of each project must be recognized. That is, the engineer should not look for the problems he wants to find but should examine the project objectively and determine the true problems involved. Correct solutions of non-existent problems are of little value.

Dr. Bjerrum then postulated that these four lessons are part of the art of civil engineering. The true civil engineer is more than an applied mathematician because he practices the art of civil engineering after he has mastered these lessons.

Dr. Bjerrum paid the University of Illinois a compliment by stating that it had been a leader in educating civil engineers who practiced the art of civil engineering. His final remark was that the dedication ceremonies for the new building should be accompanied by a renewed dedication to preserve the art of civil engineering.

MATERIALS TECHNOLOGY SEMINAR SERIES

The department of Mining, Metallurgy and Petroleum Engineering is sponsoring a series of technological seminars during this fall semester. These seminars are being presented by nationally-known men in the metallurgy department of the Battelle Memorial Institute of Columbus, Ohio.

The purpose of this series is to give the participating students and staff some insight on the application of engineering fundamentals to real problems engineers have or will have in materials processing and design. Today, more and more time must be spent preparing a student engineer with the ever-growing number of fundamental engineering concepts. This leaves less time for the student to understand the problems he will face in industry. This special seminar series is one of the forerunners in this all-important phase of engineering education. Although this program was set up as a metallurgical engineering seminar for seniors and graduate students, participation or attendance by students in other curricula is encouraged. Mechanical and industrial engineers and T.A.M. students find that many of the seminar topics are very useful and applicable to their fields.

Every Monday at three o'clock in 119 MMB, the seminars are conducted by men of extremely high calibre in their fields of research. For instance, the first lecture was entitled, *"Materials for Civilian Power Reactors,"* and was presented by J. G. Connor. Mr. Conner was employed by the U. S. Atomic Energy Commission as a metallurgist in the Fuels and Materials Development Branch before going to Battelle. His present position is Technical Advisor in the Materials Engineering Department at Battelle.

In this seminar, the evolution of nuclear energy and the development of civilian power reactors was discussed. Mr. Connor spoke about materials problems of power reactors. This seminar set the scene for the remaining lectures because it initiated the introduction of materials and materials processes discussed in following seminars.

The topics of the seminars cover a wide field of interests. William Kortier presented his lecture, *"Radioisotopic Thermoelectric Generators"* in October. This covered the future and present problem of electric power sources for remote parts of the earth and on other planets and space. The concepts discussed in this seminar create a fascinating area of concern for future graduates whose job it will be to develop the necessary materials for such important undertakings.

Probably one of the more interesting lectures coming up is on January 8th entitled *"Fibre Composite Materials."* Dale Niesz, the lecturer, will discuss the widening expanse of metallic filament-reinforced materials. Mr. Niesz' research has been in the direction of developing materials with these high-strength fibre matrices which give the best combination of required properties for specific uses. Of special importance is the idea of uniform properties throughout the material.

The speakers for this series are guests from the staff at Battelle Memorial Institute. This private, non-profit establishment has research projects underway that require a total expenditure of about $90 million a year. The Institute now has branch laboratories in all parts of the world, with the prime effort in the direction of research for industry and government.

This seminar series in the Metallurgical Engineering department appears to be a very good start toward the total preparation of University of Illinois engineers for the challenges that all engineers must face. Perhaps the idea will be carried to other engineering departments in the near future.

I'm not sure, but his computer output reads, "Ha, ha... You lose!"

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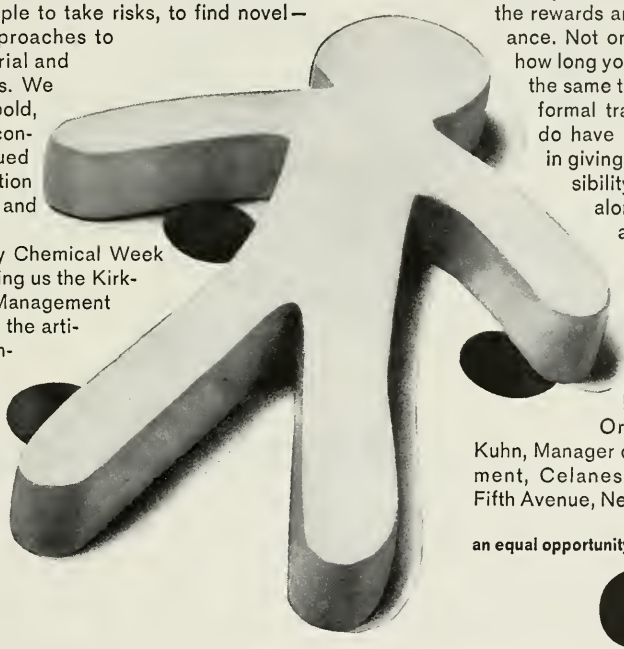

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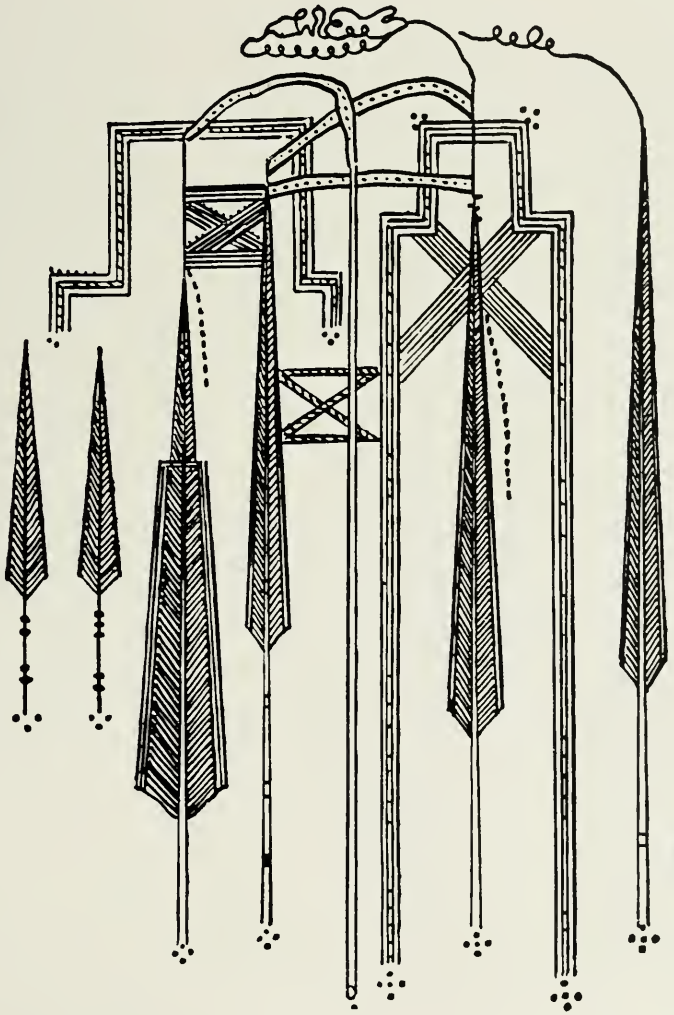

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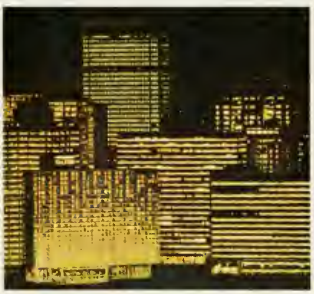

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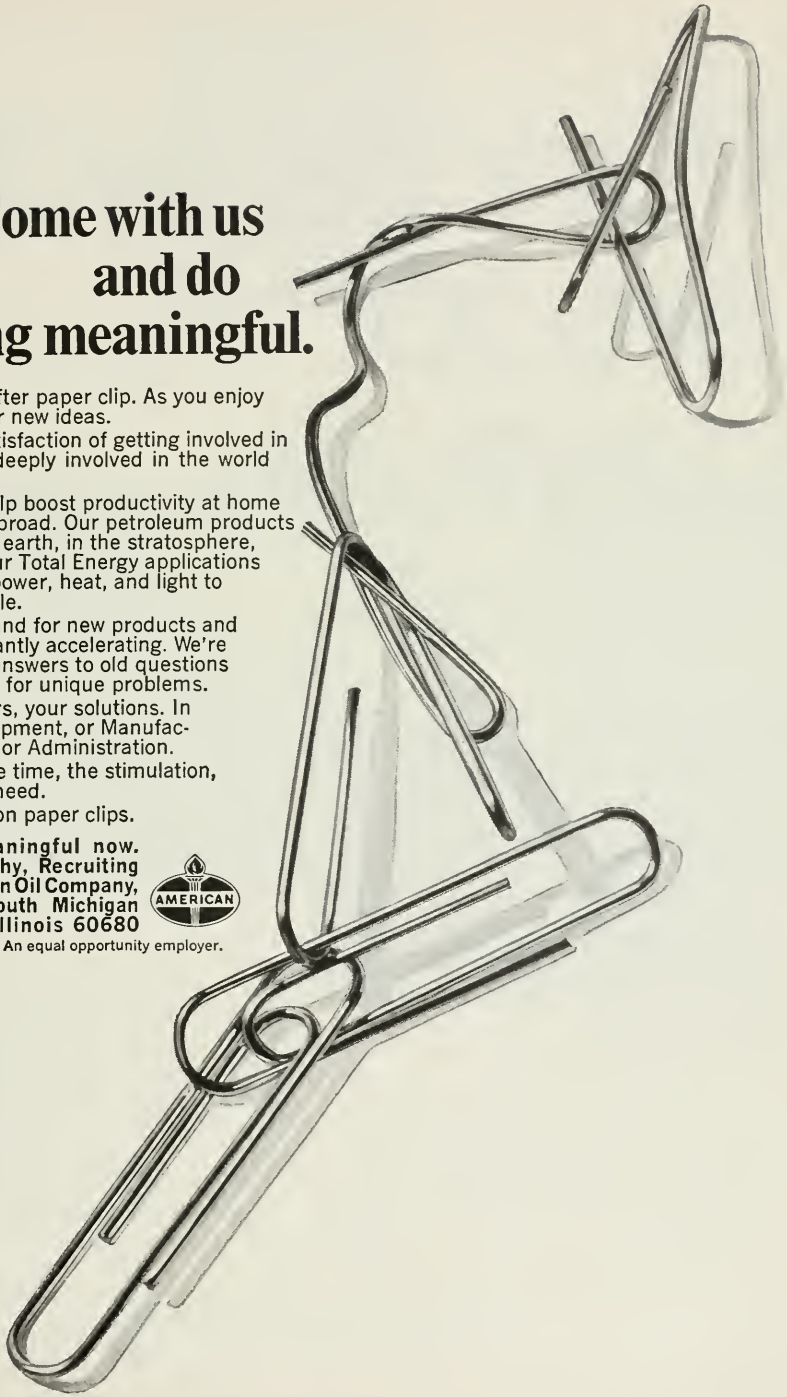

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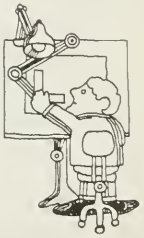

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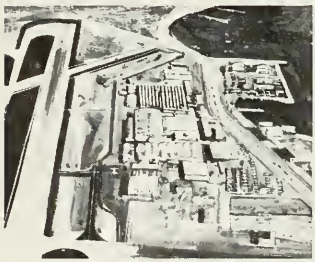

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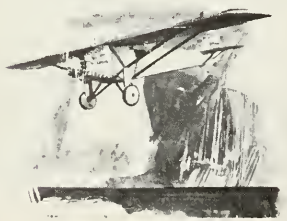

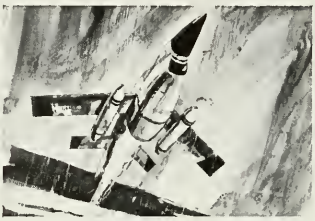

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JANUARY 1968
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COVER

The love-letter reproduced on the cover was written with a knife on a strip of bark by a girl of the Yukagirian tribe in northeastern Siberia. The whole if its sad story was told in the one ideograph. First published in 1896, it can be found in "Voices in Stone," a Viking Press book authored by Ernest Doblhofer.

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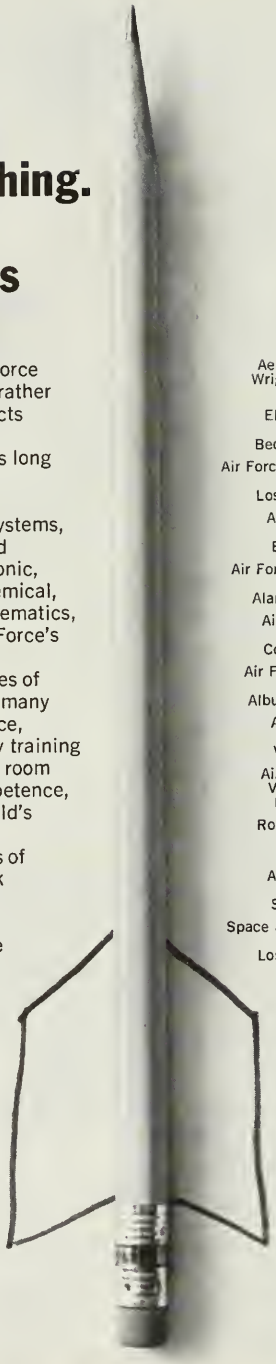

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editorial

A college education must be a complete learning experience. Unfortunately for most engineering students it has come to mean much less.

When the freshman engineering student first arrives at the University, he is no more apathetic than any other freshman. Like all beginning students, the engineer is scared but quite anxious to get involved. However, time being at a premium, the student engineer learns quickly that he must "pull his mind together" by setting aside many of the ideas he was exposed to on south campus. He must concentrate almost completely on his engineering courses if he expects to survive the ordeal of an engineering education. For the greatest part of his college career, the student's everyday associates will be comprised predominantly of engineering students and faculty. And because our faculty seems quite disinterested in encouraging students to question engineering's interplay with the rest of society, few new ideas reach the ears of the student engineer. He is caught in a web of apathy.

If it does not seem feasible to incorporate more LAS courses into our curricula, we must at least begin to discuss more readily in our classrooms the "why's and "what for's" of our studies. Engineering as it is being taught seems to be nothing more than techniques on how to mechanically solve physical problems. The college is producing engineers who are highly trained technicians but too often complete "social flunk outs."

In this issue of Technograph is an article entitled "How to Cross the Street: A Suggestion" which confirms that engineering students neither know how nor see the need to exchange ideas with the rest of the campus. No doubt this is due to the apathetic environment that exists north of Green Street.

Only after our faculty begins to realize the importance of developing the "other side" of the engineering student will the student himself realize the need. Likewise, only then will the college come up to its rightful position as a contributing and receiving member of this academic community.

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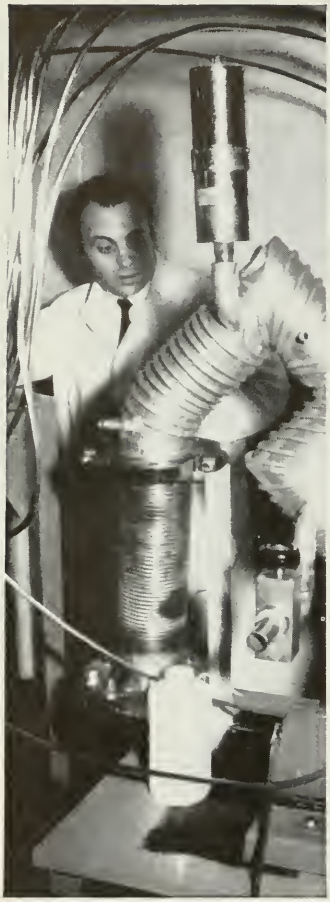

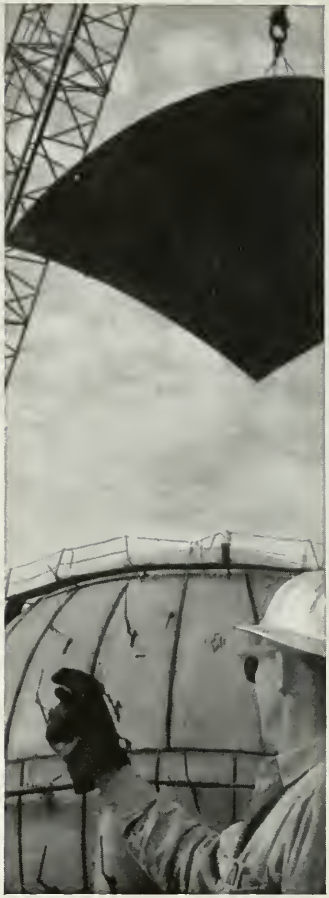

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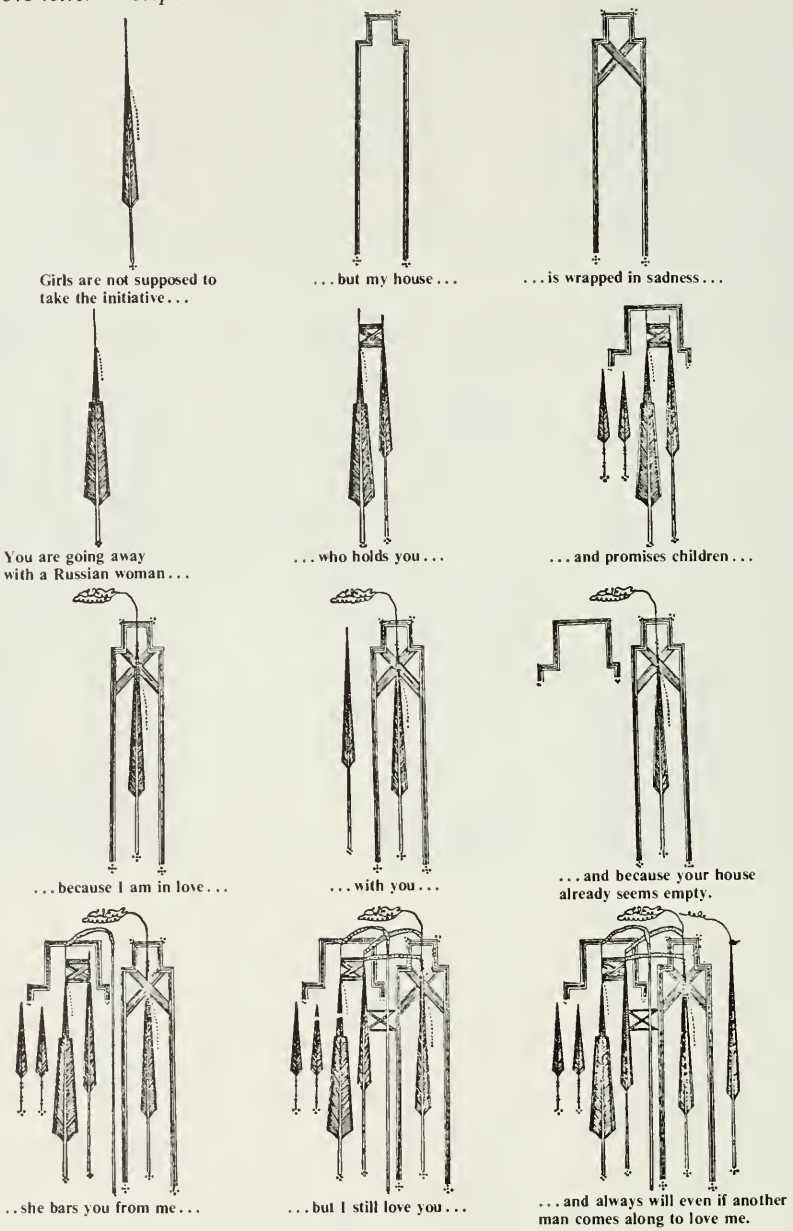
Decoding a love letter — Steps 1.... 12



The love-letter decoded above was written with a knife on a strip of bark by a girl of the Yukagirian tribe in northeastern Siberia. Historically, the problem of information exchange has been one of reproduction. However, modern technology has alleviated this problem to the extent that the difficulty is now one of dissemination of the vast quantities of information available.

INFORMATION: *HOW WE WILL FIND IT*

By Madison Post and Cheryl Trapp

In 1700 Sir Isaac Newton undoubtedly spent many nights at home leisurely reading papers and letters that academies or fellow scientists sent him. Perhaps the papers described theories, experiments, problems, or research; or maybe they were informal replies to questions and suggestions raised by Newton in earlier letters he had sent. Such communication was fine, providing a man had knowledgeable friends and access to the libraries of the academies. For the less fortunate soul who was not in the limelight, the problem of keeping informed was more acute. He could maintain no correspondence with important men and probably had access only to an institutional library.

The Industrial Revolution of the nineteenth century only compounded the problems of the average information seeker. Of course communications had been extended since the Newtonian age, but the output of documented experimentation and research papers had more than kept pace. The industrial age introduced tons of additional documents into every field-military, pathology, psychology, meteorology, physics, etc. — making the job of finding a certain article (or several articles about some specific area) a headache supreme. At the same time it became much more vital for the academician, as well as the manufacturer, to learn quickly of the new methods, processes, and research. Out of this confusion specialized libraries arose, and the discipline of library science evolved to cope with the problems of overlapping fields and reams of information.

With the advent of microfilm and finally the computer, prospects for making this information available were further encouraged. At first both old and new documents were entered into the computer in such a way that it acted much like a huge, speedy card catalogue. A person wanting information became a librarian.

An innovation to this scheme came in the late 1950's when computer languages capable of recognizing word patterns were deployed in the information retrieval field. An example of the use of such a language, Cobol (Common Business Oriented Language), in a system being used here at the University of Illinois may shed light not only on the basic approach being used today but also on the problems inherent in the approach.

The purpose of ERIC (Educational Resource Information Center), a clearing house on Early Childhool Education located on West Pennsylvania Avenue, is to gather, process, and make available all recently published information from *any* field which may pertain to early childhood education. Acquisition of documents, taking the forms of soliciting from authors, advertising in newsletters, and just guessing where articles may exist, is by far the greatest task. Most materials come from well-known research centers, but important works are encountered in psychology experiments working with rats, in hospitals, in Switzerland, and other unusual places. However incomplete the information is, a resume is written for each document. The two keys to this resume are the retrieval terms, phrases taken from a reference book which describe all aspects of the document, and the abstract or summary. Common retrieval terms are academic performance, cognitive development, siblings, and family life. Out of 3000 terms in the Thesaurus, about ten apply to any document, and these provide the retrieval system with its usefulness.

Madison Post is a senior in the five-year Engineering-LAS curriculum. Madison is majoring in Electrical Engineering and Mathematics and hails from Springfield.

Cheryl Trapp is a Sophomore in Civil Engineering. She is a member of the Society of Women Engineers.

Every month the resumes and documents from this and seventeen other clearing houses in the system are sent to North American Aviation for microfilming. Each clearing house in the system receives and files a microfilm copy of every resume and article. Via Cobol a computer associates a document's title, author and date with its retrieval terms.

One wishing to use the system might call the clearing house and ask for a bibliography on "science curriculum for four-year-old Head Start children." The retrieval terms pre-school, curriculum, science, and Head Start would be given to the computer, which would print out the bibliography. After reading the list of articles and authors, one may want to read an article or two. He can go to any public source for the articles, or if the document is not published publicly, he may read the films at the clearing house and Xerox copies. The whole process from telephoning to receiving the bibliography takes less than 48 hours.

The problems of this retrieval system, which is very typical of the majority of systems in use today, may be tabulated as:

1) acquisition of a wide variety of documents from varied sources

2) processing of the documents

3) condensation of the resumes of articles processed at several clearing houses

4) production and storage of microfilms

5) oversupply and uncertainty in obtaining the required information

The fifth problem may not be readily apparent from the above example, but suppose one wants information about a specific problem in the science program for Head Start children. Naturally he would think that the article he desired could be found somewhere among the Head Start articles, so his question was properly phrased. But perhaps this problem is mentioned only in a document which advocates a different approach to early education. The problem, about which information is desired, may merely illustrate advantages of the different approach over Head Start. The retrieval terms for this article may or may not include Head Start. Obviously this person is uncertain of receiving the information he wants, and he is certainly given an oversupply of information.

With these deficiencies in mind, in September of 1967 a newly proposed information retrieval system, Cognitive Memory, came into being at the University of Illinois. The principle investigator is Heinz von Foerster. This new approach will alleviate the burden of an oversupply of information to the individual seeking an answer to a question. The object of this system is to set up a computer with self-organizing elements in such a fashion that as a whole it will display some traces of intelligence. "Intelligence" in this context means some degree of abstraction, recognition, recall, learning, and adaptation.

In contrast to present information retrieval systems, Cognitive Memory utilizes environmental situations which are presented to the computer system and a form of "memory." When one looks at the sky on a clear day, his brain goes through some unique process of recalling that the sky is blue. This is an example of cognitive memory. When the Cognitive Memory system is developed, it will have its own unique method of making "decisions" about environmental situations.

The eye detects various objects in nature and relates them to the brain. The brain in turn determines what the objects are. In a frog, for example, part of the retina detects the curvature of the edge of dark objects. Obviously this is an insect-detector since frogs live on insects. The main purpose of this example is to illustrate that given an insect, a detector can be devised which detects this insect. Or more generally, if some structure exists in an environment, a system may evolve which can detect this structure.

Another example of cognitive memory concerns calculations of numbers. When numbers are considered in a present day information retrieval system, the answers to various calculations are determined by calling the "address" of the result of a specific operation. Before computers were built a person could made a multiplication

X • Y	0	1	2	3	4	5	6	7.....10
0	0	0	0	0	0	0	0	0.....
1	0	1	2	3	4	5	6	7.....
2	0	2	4	6	8	10	12	14.....
3	0	3	6	9	12	15	18	21.....
4	0	4	8	12	16	20	24	28.....
5	0	5	10	15	20	25	30	35.....
6	0	6	12	18	24	30	36	42.....
7	0	7	14	21	28	35	42	49.....

Fig. 1

table (fig. 1) for the numbers x and y. If this table were to accomodate factors x and y up to an order of magitude of n, using 8 ½ by 11 inch paper, the thickness D required for the multiplication table would be: [1]

$$D = n \times 10^{2n-6} \text{ cm.}$$

For example, a 100 by 100 table has thickness, $D = 2 \times 10^{2} = .2$ mm. or about one page of paper. However, if n equals ten, $D = 10 \times 10^{14} = 10^{15}$ cm. This thickness would be about one-hundred times the distance between the sun and earth. A "librarian" moving with the velocity of light would require on the average of one-half day to look up a single entry in the book. A Cognitive Memory computer would adapt; that is, it would first learn by experience the operations required. This system would change its internal organization as a consequence of interaction with its environment. This internal organization should remove uncertainties with respect to predictions of future events in its environment.

When constructing a Cognitive Memory computer for multiplication, the environment to which the computer is to be exposed and what the computer is supposed to learn must be determined. The environment is a reward

system such that a rejuvenation of its parts occurs when it comes up with a correct result. First it is assumed that the computer has a built-in understanding of multiplication. The computer must now learn a number system such as decimal or binary. This system should "learn" because "learning" enables it to make inductive inferences in order to compute future events from past experience.

The Coordinated Science Laboratory of the University of Illinois, which is now engaged with Cognitive Memory, proposes to conduct a research program to establish the foundations for systems which premit symbolic discourse in the form of natural language between man and machine and to demonstrate the superiority of such systems over conventional information storage and retrieval systems. Should this form of system ultimately be realized in useful form, it would undoubtedly have advantages over current systems. One such advantage is the acceptable form of requests. Presently a "query" consists of a document set in crude retrieval terms which is similar to going to a grocery store for beer and asking for something in bottles of a long cylindrical shape. Of course the result may not be what was wanted. In the normal use of language, a question has the function of describing the particular gap in one's knowledge that needs filling. It is this form of query which is appropriate for a Cognitive Memory system.

The group of faculty members from various departments on this campus who are working on Cognitive Memory have set up a six year plan for the development of a Cognitive Memory system (Table I). This is by no means a permanent timetable since research may either speed up or slow down the present line of investigation. The first step is to set up a data structure and test this structure with present computer facilities. The concept of "cellular logic" will be investigated at this time. By the end of the second year, it is hoped that inter-system structures will be finalized and that a computer system will be rented or purchased. During the third year the development of system programs may be initiated. The fourth year will bring testing of the data structure. Results obtained during the first four years will be used during the fifth year to modify system programs and to expand the computer system. Finally, it is hoped that in the sixth year the entire system may become operable.

The ground work has been laid for a much more efficient information retrieval system. However, the full value of a Cognitive Memory system is far from realized due to limited knowledge of linguistic and cognitive structures as well as present limitations of computing systems.

1 **Memory Without Record**, Heinz von Foerster, 1965.

TABLE I

YEAR	THEORY	SIMULATION ON EXISTENT COMP. FACIL.	HARDWARE (HW)	SOFTWARE	SYSTEM
1					
2	Data Structure Syntax, Eidology	Data Structure Interim HW	Finalize Interim Syst Architecture		
3			Contemplate HW Rental or Purchase		Preparation of Data Structure
4	Evaluation of System Tests		Systems Integration	Development of System Programs	Testing of Interim Design
5	New Development Based on Tests		Possible Expansion of HW		Modifications According to Results
6	Evaluation			Debugging	Final Testing and Operation

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CHRISTIANITY vs. SCIENCE

By Jim Moore

Part 2.

THEISM

Last month we saw that philosophical speculation can never determine whether miracles occur. Rather than the armchair philosopher, the scientist and historian must answer the miracle question. Furthermore we saw that miracles are not intrinsically impossible events. That is, miracles do not occur *only* if one so defines non-occurring events. But if miracles in the ordinary sense of the word may occur, then this fact calls for a clarification of the word "miracle."

What distinguishes events that merit the appellation "miracle?" The significance of events that are normally called miracles does not lie in the fact that they violate a rigid, universal framework of natural law, but in the fact that they are *contextually unique* — and that their uniqueness lends prestige or authority to a miracleworker, (providing that an agent is involved). By contextually unique it is meant that the events were extraordinary and/or unique within the culture or epoch in which they occurred. (e.g. A first century story relates that two men see each other and communicate with each other between Rome and Athens by looking and speaking into an unusual metal box.) In light of this clarification a miracle can be at least tentatively defined to be a unique event of great significance within a certain historical context.

STARTING POINTS

The subject of this article is the revelation of the Christian God and man's rational competence to know Him. As we shall see, the unique claims of Christianity rest here. The question of miracles is logically prior in that miraculous events are intimately involved with the validation of the Christian belief in God. In order to show the correlation between miracles and Christian theism we must first digress to discuss the nature of the problem of science and Christian theism and to reveal the scientific-philosophical procedure by which we, as engineers or prospective scientists, may effect a solution.

In approaching the problem of theism versus science and the philosophy of science one encounters a multiplicity of statements relating the nature of the problem. John Hick offers us an eloquent and instructive example.

> The sciences have cumulatively established the autonomy of the natural order. From the galaxies whose vastness numbs the mind to the unimaginable small events and entities of the subatomic universe, and throughout the endless complexities of our own world which lies between these virtual infinities, nature can be studied without any reference to God. The universe investigated by the sciences proceeds exactly as though no God exists.[1]

But the obvious question remains: Does it follow from this account that there is no God, or can an open-minded, scientific outlook and a dogmatic, Christian theism be reconciled?

It seems to be too much to ask engineers and prospective scientists to commit intellectual hari-kari by blindly affirming the existence of an invisible and intangible God. These are men who work with the "stuff" of the world and their "belief" in the theories and laws which describe its behavior is predicated on an intimate acquaintance with objective data accruing from careful experiment. To plunge into a morass of fuzzy-minded, non-evidential religious belief is, for the thoughtful engineer and scientist, to embrace a disconcerting inconsistency between daily life and religious practice — disconcerting because the dichotomy of the secular (scientific) and the sacred (religious) appears to be an unsupported presupposition which the thoughtful engineer and scientist must question.[2]

This problem of scientific belief challenges us to consider the primary philosophical issue of presuppositions. Every argument and methodology has them. Therefore it is imperative that we understand that there are at least two kinds of people in the world: those who have presuppositions and admit them and those that have them and do not admit it. Of course the latter group is more dangerous in that their sovereign decisions unwittingly distort the conclusions which they draw from their universe of data.

To alleviate the perversion caused by inadmissible or otherwise unknown presuppositions, effective scientists and engineers consciously adopt presuppositions with minimum factual content. They assume that: (1) knowledge is possible. (2) the universe is orderly. (3) men report their conclusions honestly.[3] As empiricists these men use their presuppositions to justify investigation of the universe. Theories and models are then constructed imaginatively and checked inductively in attempts to render the resultant data intelligible. Finally a world-view is constructed from the processed data.[4] Observation, Correlation, and Experimentation — in short, this is the procedure followed by scientists and engineers in search of truth about the universe.[5]

THE THEOLOGIAN'S SYNTHESIS

If we cannot accept the existence of God by blind faith and retain our intellectual respectability and, if we understand the presuppositions and methodology employed in our quest for truth, then what sort of reasonable systhesis can we expect which will be relevant to a rational belief or disbelief in the Christian God? The philosopher Paul Schlipp frankly relates the synthesis we cannot expect.

> There can be no "science" of God. God may be a claim of (more or less) reasonable faith; He may be a (more or less valid) metaphysical hypothesis (and all metaphysics is purely speculative); He may even be the answer to someone's "religious" need. But, in the very nature of the case (i.e., because He is thought of as infinite, whereas man and all man's knowledge are only finite), He cannot be the object of scientific analysis and investigation.[6]

Is Schlipp correct? Is science to be short-circuited in a search for God? Surely he must admit that science offers the would-be believer firm epistemological ground on which to stand for its ground (scientific method) has supported the intellectual weight of scientists (both Christian and non-Christian) throughout centuries of research and technological progress. Let us see if theologians have stood on this ground where the grass appears to be decidedly greener than on prairies of unverifiable subjective experience and mystically intuitive God-claims.

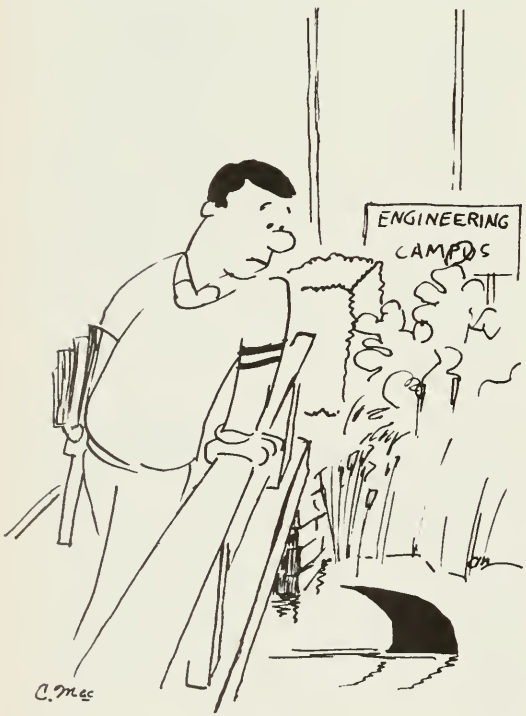
On the one hand we have theologians who have swallowed Schlipp's statement. In the temple of the mind where Einstein held his "gedanken experiments"[7] these theologians slaughter their intellects on the metaphysical altar they have erected to G O D — a linguistic symbol which is meant to connote "being" that is undetectable and wholly unverifiable either by tangible, historical contact *or* by a theoretical thought experiment.[8] But the sheer folly of this cult will become apparent if we describe a similar situation. What would we think of a physicist who believed in the existence of undetectable, wholly unverifiable particles which he called "glerps?" Very little, I expect, when we discover that the evidence which the physicist submits for the particles' existence is no more than his compelling, irrational, and evidently mystical feelings. Perhaps his belief was elicited by mere indigestion! Consequently, the Christian theologian must be able to distinguish " the Lord on high" from both gastronomical pie and metaphysical pie in the sky. In the last analysis only scientific method will rescue theologians and physicists from the snare of nonsensical discourse and mystical thought life.[9] Let us see why this is true.

Theoretical construction must be subject to specific, factual investigation if it is to aid man's world-view and if, in fact, it is to make sense. If one seeks to theorize where verification is impossible in fact or in principle (as with glerps and gods) he is left to sheer speculation and blithering pseudo-statements. (note Schlipp's viewpoint) This is the case because statements which propose the existence of glerps and unverifiable gods are not genuine assertions. Such propositions may indeed constitute a peculiar kind of "language game" but how can one determine whether the game represents reality at all?[10] One must face the fact that these propositions are compatible with anything and everything and

therefore they say precisely nothing. They are neither true nor false because there are no truth conditions relevant to establishing their truth or falsity. There is no "check-up" procedure relevant to determining their truth or falsity. At best they tell us of the psychological conditions of the people who uttered them. Hence, if one is to make sense when speaking of God or of particles he must be certain that his assertions can be checked in some objective fashion.[11] Checking is accomplished by scientific method.

However many Christian theologians refuse to succumb to Schlipp's logic. They have left their ivory towers of theologizing and are embracing the down-to-earth verification criteria of the modern scientist. They rely on an empirically verifiable God and objective attestation to the veracity of his revelation to man. They insist on discovering and assimilating these facts by scientific method. They have concluded that absolutes, whether ethical or spiritual, cannot be obtained by analyzing the human situation from within. As a consequence, particular revelation is seen to be the touchstone for man's knowledge of absolute truths — a palpable word from outside the human situation.[12]

Two factors have aided this doctrinal development. First, these theologians realize that they must make sense when speaking of the reality of God and therefore their assertions must be amenable to some sort of objective verification. Second, it appears that absolute ethical and spiritual truths will never be derived from the human situation because every human being is caught up in the flux of life. There is no absolute resting place within the human situation from which one can gain a comprehensive, absolute perspective on the universe. Consequently one must seize upon an empirical manifestation of the God who speaks to man — the God whose statements constitute absolute ethical and spiritual truth.[13]



If however there has been an empirical manifestation of God then obviously (contra Schlipp) there can be a science of God in some sense of the word science. Indeed, there may be a basis for rational belief in God. One might also expect that such a belief would be akin to a scientist's acceptance of his empirical data as recorded in a laboratory manual or as generalized by a theory or law. But where shall we turn to find an incarnation of God?

DATA ON DIETY

Scores of men throughout history have either claimed to be God or have been elevated to that position in the public opinion. Scores of men have met with ignominious failure when compelled to validate their claim or the claims of others for them. It is therefore interesting to discover what sort of evidence would be required of a pretender to Deity in order to substantiate his claim in the mind of an engineer or scientist. It seems that almost no amount of evidence would be sufficient to prove to me that Joe Schmo in my Physics lecture was the controller of the universe and maker of heaven and earth. Or could there be sufficient evidence? Those theologians and laymen who believe in the Christian God on scientific grounds have found sufficient evidence to warrant unqualified belief in His existence and personal reality.

In the orthodox tradition, Christianity avers that God did, in fact, enter the finite flux of human endeavor. By a series of unusual events nearly 2000 years ago in the land of present-day Israel it is claimed that God entered human history in a unique person known by his contemporaries as Jesus of Nazareth. It is recorded that this self-confessed God-man spoke absolute ethical and spiritual truths and attested his claims and pronouncements by performing miracles and, ultimately, by returning to life after a brutal murder at the hands of the religious authorities.

The historical data for these "laws" of Christianity (analogous to physical laws of nature) were collected by eyewitnesses at the time of the events and were subsequently recorded in a "laboratory manual" of primary source documents. The scientific Christian theologian and layman begin with the precollected data

of history as found in the New Testament.[14] They find the data to be free from systematic error and are assured of their facticity and veracity in the same way that one may know the certainty of the events in World War II beyond the shadow of a reasonable doubt by reading (for example) Dwight Eisenhower's *Crusade in Europe*. [15]

We are now in a position to understand the centrality of miracles to the Christian God-claim. First-century men were as skeptical as we would be if confronted with a claimant to deity.[16] Indeed, it is difficult to conceive of a modern man who would be allowed to remain on the streets for three years after claiming to be God. However, it is recorded that Jesus went about doing remarkable things which we call miracles — things which won him a tremendous following from the ranks of his monotheistic countrymen.[17] Throughout his public ministry it was apparent that his ethical and moral character was entirely congruent with his claim to be God.[18] When asked for an ultimate sign of his authority and godhead Jesus replied that he would return to life from the dead.[19] The documents record the events of the ensuing resurrection and post-resurrection appearances of Jesus in clinical detail. Taken together with Jesus' claims, character and other miracles, the resurrection constitutes the fundamental vindication of Christian theism.[20]

Experiment

In conclusion we go a step farther. Scientific method is incomplete without experimental verification of hypotheses. Yet it is obvious that, in the case of Jesus, historical experimentation *qua* science in efforts to establish a hypothesis concerning his identity is impossible. Therefore it is necessary to see what sort of "experiments" men performed in Jesus' day in efforts to establish the full truth of what he claimed. Although men saw, touched and heard Jesus, their primary mode of verification was becoming his personal friends — becoming his disciples. In a personal relationship the true character of any individual is revealed far more clearly than by any list of data. Yet personal knowledge should never be set over against objective facts. Rather, one begins to know a historical character personally as he first learns of him objectively, the data serving as a necessary check on any ensuing existential experience.

With these thoughts in mind it is incumbent upon men of today — especially those of us with the technical tools of scientific method — to recognize that the same Jesus who lived and spoke and died and (if his claims are true) returned to life in proof of his claims — this Jesus who lives today asks men to experiment as did men of old by trusting him to be all he claimed to be and by relating to him as disciples.[21]

> The biblical tradition declares that God, the source from which all existence comes, demands from man the response and responsibility of a person, rather than the reaction of a thing to external impacts. Christianity sharpens the question by declaring that by the Incarnation, God himself entered into and participated in the career of man to confront man with a Person whom man can accept or reject, but toward whom he cannot be neutral. [22]

In that modern science has experienced a great degree of success in discovering truthful relations about the universe, it has contributed immeasurably to man's ability to handle a problem as ostensibly complex and controversial as belief in the Christian God. By applying scientific methods we have seen that historical "observation" and a subsequent correlation of data are necessary conditions for a meaningful and rational belief in *any* god. In the case of Christian theism, personal "experimentation" taken together with these two steps is both necessary *and* sufficient to establish the certainty of man's historic and personal encounter with God as manifest in Jesus Christ. I am persuaded that until we realize that facts and the faith of a scientist (in that order) produce the unshakable trust of a rational belief in this God, we shall be doomed to spiritual schizophrenia in attempts to derive ultimate answers to religious questions from the flux of human opinion.

NOTES

1 **Philosophy of Religion** (Englewood Cliffs, New Jersey, 1963) pp. 37-38.

2 D. M. Mackay, ed., **Christianity in a Mechanistic Universe** (Chicago: Inter-Varsity Press, 1966), pp. 33-34. This symposium of British scientists constitutes a lucid and competent survey of the problem of Christian belief as related to the universe described by the natural sciences.

3 Edward J. Carnell, **An Introduction to Christian Apologetics** (Grand Rapids, Michigan: Wm. B. Eerdmans Pub. Co., 1948), p. 94. Also cf. David L. Dye, **Faith and the Physical World: A Comprehensive View** (Grand Rapids, Michigan: Wm. B. Eerdmans Pub. Co., 1966), pp. 33-50.

4 John W. Montgomery, "Constructive Religious Empiricism: An Analysis and Criticism," in **The Shape of the Past** (Ann Arbor, Michigan: Edwards Bros. Inc., 1962), pp. 265-266.

5 For a detailed discussion of scientific methods see Max Black, **Critical Thinking** (Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1965), chaps 17-19.

6 Paul Arthur Schlipp, "Science, Theology and Ethical Religion," **Zygon**, I (June, 1966), 189-190.

7 Edwin L. Goldwasser, **Optics, Waves, Atoms and Nuclei** (New York: W. A. Benjamin, Inc., 1965), pp. 195-196.

8 See Paul Tillich, **Systematic Theology** (Chicago: University of Chicago Press, 1951), Vol. I, pp. 235-249. and John Macquarrie, "How Can We Think of God" in **New Theology No. 3** ed. Martin E. Marty and Dean G. Peerman (New York: Macmillan Paperbacks, 1964), pp. 47-52. This essay first appeared in the July, 1965 issue of **Theology Today**.

9 Carl Henry has astutely observed that "from the objective-transcendent personal God of Judeo-Christian theology, therefore, neo-Protestant interpreters have moved in recent generations to the nonobjective-transcendent personal God (Barth and Brunner), to the nonobjective-transcendent impersonal Unconditioned (Tillich), to the nonobjective-mythological-transcendent personal God (Bultmann), to nonobjective-nontranscendent religion." If all objectivity has been lost then we

(Notes continued on Page 28)

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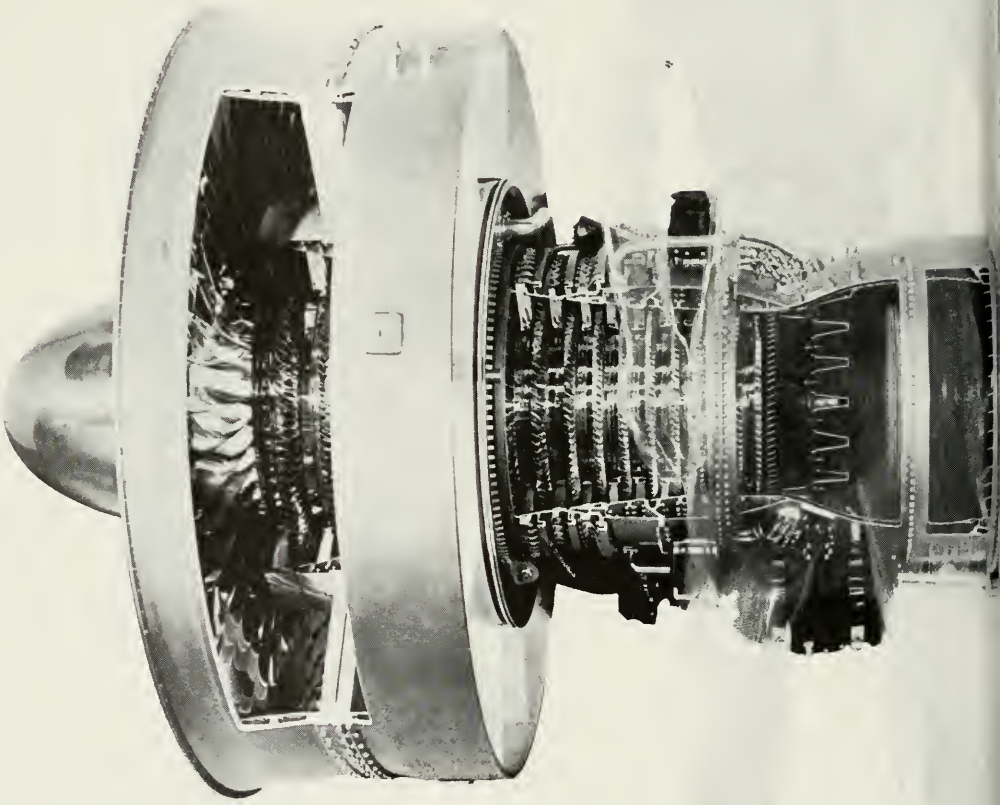

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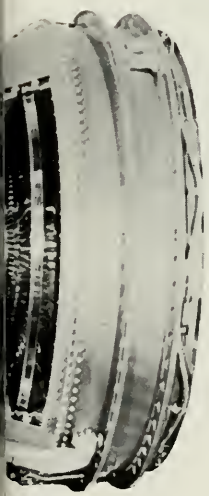

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have perforce lost all means of impartial evaluation of Christianity. Modern man is then in the lamentable religious position where "no reason can be adduced for choosing one faith or set of religious beliefs over its opposite, or, for that matter, for choosing any at all on rational grounds." (**Frontiers in Modern Theology** (Chicago: Moody Press, 1966). pp. 148-149.)

10 See Fredrick Ferre, **Language, Logic and God** (New York: Harper and Row, 1961), pp. 58-61. and Walter Kaufmann, **Critique of Religion and Philosophy** (Garden City, New York: Doubleday Anchor Books, 1961), pp. 173-181. Kaufmann distinguishes between the assertions "God exists" and "God **really** exists" and concludes that the latter has no clear meaning whereas the former may be a meaningful component of the universe of Judeo-Christian discourse (language game).

11 Antony Flew and Alasdair MacIntyre, eds., **New Essays in Philosophical Theology** (New York: Macmillan Paperbacks, 1964), pp. 78-95. Concepts derived by contemporary analytic philosophers have proven useful in clearing up much of today's jumbled religious jargon.

12 "In a moving symbolic novel, **Mount Analogue**, the late surrealist Sanskrit scholar, philosopher and poet Rene Daumal has one of his leading characters say: 'Experience has proven, I told myself, that a man cannot reach truth directly, nor all by himself. An intermediary has to be present, a force still human in certain respects, yet transcending humanity in others. Somewhere on our Earth this superior form of humanity must exist, and not utterly out of reach. In that case shouldn't all my efforts be directed toward discovering it? Even if, in spite of my certainty, I were the victim of a monstrous illusion, I should lose nothing in the attempt. For, apart from this hope, all life lacked meaning for me.' 'But where was I to look? Where could I begin? I had already covered the world, poked my nose into everything, into all kinds of religious sects and mystic cults. But with all of them it came down to the same dilemma: maybe yes, maybe no. Why should I stake my life on this one rather than on that one? You see, I had no touchstone' (tr. Roger Shattuck (New York: Pantheon Books, 1960), p. 59). John W. Montgomery, "Toward A Christian Philosophy of History," in **Jesus of Nazareth: Savior and Lord** ed. Carl F. H. Henry (Grand Rapids, Michigan: Wm. B. Eerdmans Pub. Co., 1966), pp. 239-240.

13 Metaphysical dualism applied here to a prior belief in God is a philosophical a **priori.** In the words of Sir Robert Anderson, "...it implies a double incompetance, the incompetance not only of man to know God, but of God to make himself known. But the denial of competance is the negation of deity." (**A Doubter's Doubts About Science and Religion** (London: Pickering and Inglis, 3rd Ed., 1924).)

14 For an excellent and comprehensive study of the scientific theologian's methodology see John W. Montgomery, "The Theologian's Craft: A Discussion of Theory Formation and Theory Testing in Theology," **Journal of the American Scientific Affiliation,** XVIII (September, 1966), 65-77, 92-95.

15 The eminent textual scholar Sir Fredrick Kenyon has written, "So far from the New Testament text being in an abnormally unsatisfactory state, it is far better attested than that of any other work of ancient literature. Its problems and difficulties arise not from a deficiency of evidence but from an excess of it. In the case of no work of Greek or Latin literature do we possess manuscripts so plentiful in number or so near the date of composition." (**Recent Developments in the Textural Criticism of the Greek Bible** (London, 1933), pp. 74-75.) Perhaps the best short work on the subject is F. F. Bruce's **The New Testament Documents: Are They Reliable** (Chicago: Inter-Varsity Press, 1967).

16 See Luke 5:17-26; John 7,8; John 20:24-31 for examples of first-century scepticism.

17 Cf. John 11:45-48 That Jesus regarded Himself as no less than Jehovah God of the Jews is patent in New Testament. See John 8:56-59.

18 Cf. John 5:17-24; 10:22-39; 14:9. One of the most startling aspects of Jesus' public image was that friend and foe alike confessed his sinlessness and freedom from guilt. Pilate and Herod, Luke 23:14,15; Judas, Luke 27:4; Malefactor, Luke 23:41; Roman centurion, Luke 23:47; Peter, Acts 3:14; I Peter 3:18; Stephen, Acts 7:52; John, I John 3:5; Paul, II Corinthians 5:21.

19 John 2:18-22; Matthew 12:38-40.

20 Beginning with Paul the Apostle (I Corinthians 15:14) men of all ages have recognized this fact. Frank Morison set out to disprove the resurrection and the sheer facticity of the event drove him to God and to answer the only question for which he could not conceivably rationalize an answer, namely, the title of his book. **Who Moved the Stone?** (London: Faber and Faber Ltd., 1959).

21 Cf. John 3:16-21; 8:12-36. An excellent exposition of the New Testament data on this subject is available in John Stott's **Basic Christianity** (Chicago: Inter-Varsity Press, 1964).

22 Emerson Shideler, **Believing and Knowing** (Ames, Iowa: Iowa State University Press, 1965), p. 36.

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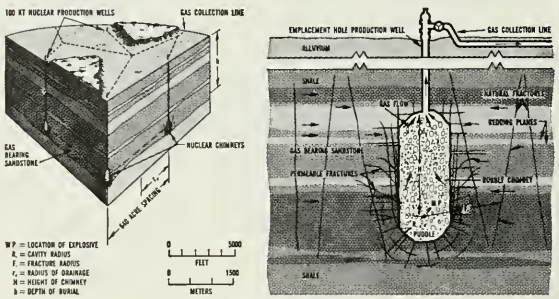

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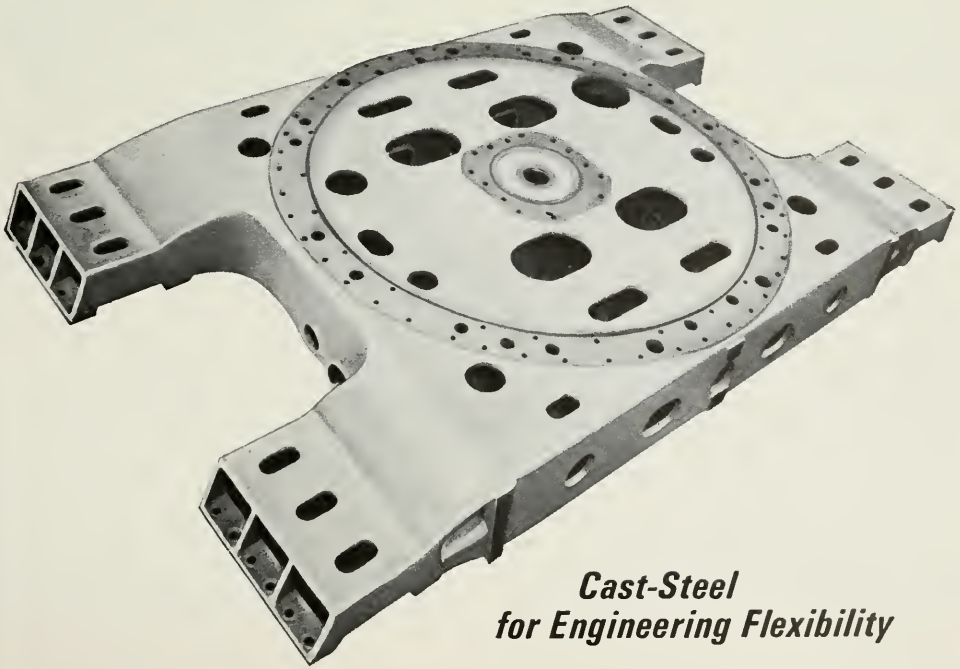

Cast-Steel for Engineering Flexibility

HOW TO CROSS GREEN STREET: a suggestion

By Edwin Black

Edwin Black, a freshman majoring in English hails from Chicago. He has numerous achievements in artistic and freelance writing.

What is the mythical dimension that exists north of Green Street? Cross that almost legendary boundary and you enter a world of slide rules, computers, and coefficients. Wander past Green and you wander past the last outpost of what students call the "with-it." The tales go on and on and on, with the engineering students that inhabit the stately buildings north of Green Street just going on about their work and their lives.

How does the rest of the university see the student of engineering? Does he have an image? What is it? What makes him similar to the other students? What makes him different? To find out I circulated 300 questionnaires to men and women of all colleges and majors outside the Engineering College and asked for their honest opinions about engineering students.

The nature of the survey sought to poll opinion, whether founded or not; in this way an image of the engineering student could be seen. The survey was concerned with the "picture" others had of engineering students and why. Information about the interviewees' college, major, age, housing, and regional origin was supplied. Answers could not be divided on the basis of any of these. However, there was a clear cut difference between the sexes in answering. The women usually had a greater knowledge of engineers than the men; this could be explained by an abundance of female responses indicating they had dated male engineering students, and a complete lack of any men dating female engineering students.

The "picture" most had of the engineering student was one of a quiet student that stays pretty much within his own circle — namely, other engineers. Half of the men and most of the women indicated they felt engineering students were quiet, while not one could even imagine an engineer being loud. Furthermore, most men and women saw engineers as unaggressive and apathetic.

As a fellow student, the surveyed persons all thought an engineering student was a very good student. Nearly all answered engineering students seem to be more devoted than others. Most of the men and women also felt that engineering students took harder courses, got higher grades, and took more credit hours on the average. Almost 75% readily admitted they felt engineering students were all around better students. One female junior majoring in history remarked, "I don't know what's different about them. They seem to be more devoted. They're always in their studies."

Yet the laurels of their scholarship is soon negated when that very scholarship consumes the student. Two male freshmen majoring in chemistry remarked that their only friends in engineering were from their dormitory floor. "You don't meet them like you meet other fellows," said one of them. "They keep to themselves and you usually have few common interests with them, unless you're an engineer too," said the other. The survey indicated the students thought engineers would make good friends, but many qualified their answers as this sophomore fraternity member majoring in photog-

raphy did: "I'm sure they would be good friends to have, but only to other engineers, or at least that's my impression."

And it is definitely the impression engineering students present that is responsible for the legends north of Green. The problem lies in a technical obsession to gobble up whole heaps of knowledge and training, without allowing time for the swallowing. They immerse themselves in an overload of credit and classroom hours. Constant and diligent studying is mandatory to remain above water with such a burden.

Two LAS juniors are shown commenting about engineering students.

If this is the case, the engineering student is not fulfilling his expectation as a human being; he is not receiving that development so essential to later life. He is merely fulfilling his requirement as a machine, functioning as precisely as possible, unplugging when the specific task is done. The average engineer does not want to study a foreign language or literature. An industrial engineer frankly remarked, "Why should I study about English history or some type of poetry. My job involves statistics, not poems or the study of Kings and Queens of Great Britain." The engineer then becomes a highly specialized machine only as good as his programming. When that programming becomes obsolete or unnecessary, the engineering student is left helplessly dwindling amidst a complex of useless information. This can hardly be an acceptable state.

An industrial administration major said, "They don't want to have anything to do with anything unless it is somehow connected with engineers." On this question most of the polled opinions said they thought engineers participated in extra-curricular activities, although few could cite any that were not connected with the Engineering College. Most of the men felt engineers would benefit in an extra-curricular function, although 50% of the women disagreed. In response to the question, "Do you think engineering students are followers rather than leaders?" Most males thought they were not while 50% of the women thought they were. However, interviews with many men indicated they had no real basis for their answer. Most could not name an instance they knew of where an engineering student performed exceptionally in any extra-curricular activity. The women, on the other hand, could usually cite examples of a lack of enthusiasm. One electrical engineering student commented, "Why should we waste our time in things that don't interest us?"

"It's not interesting to them," said a senior majoring in biology. "That's what it is. Their interest lies in engineering affairs and they ignore nearly everything else." Another student remarked, "I think engineers don't care about anything else because they're never willing to go out of their little world." Most of the interviewees said nearly the same thing — engineers seem to be in their own little shell.

The consensus of the persons polled is that they see an engineering student as one who is quiet, "in their own world," and apathetic. They are a group of students preoccupied with a credo of progress — and they strive for excellence and perfection. Consequently they involve themselves in their work and field as entirely as possible. But the notion remains that the university is a social and academic experience; this is the notion lost to the student of engineering. And ignoring this notion sets him apart from other students at the university.

The engineering student concentrates on his tables, designs, slide rules, and T squares, all articles of his trade intended to ameliorate a society he quite often refuses to participate in. The engineering student cannot live in a world comprised of calculations alone. He must cultivate the essentials of a good engineer (logic, reasoning, and determination) and apply them as a human being, and not merely as a human machine.

When a man looks only to one road, he is lost at the detour. When a man walks down only one path, its end is his own. As it stands, the engineering student, knowing how to live on only one side of the street, cannot cross over when he suddenly becomes interested in the lights on the other side.

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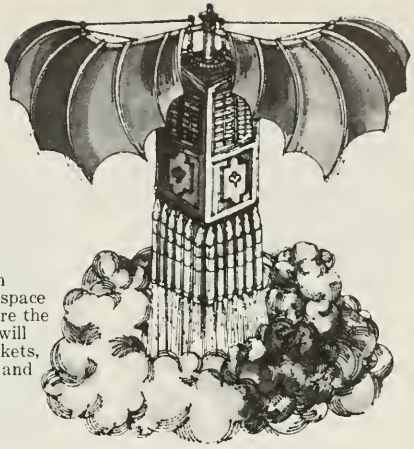

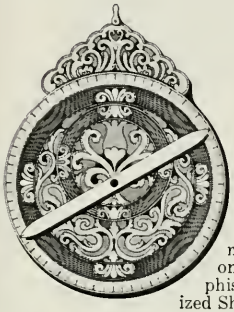

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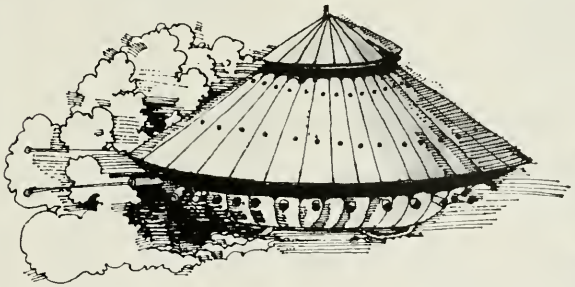

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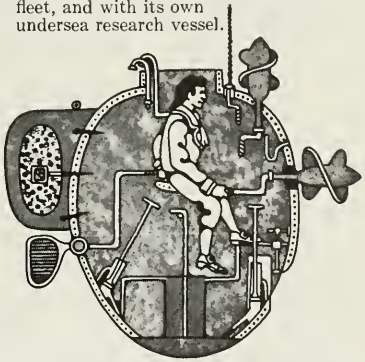

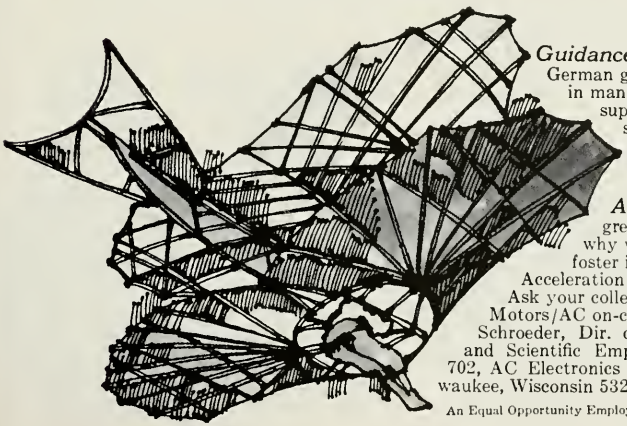

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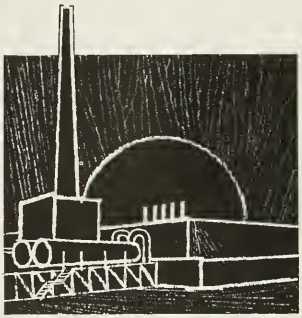

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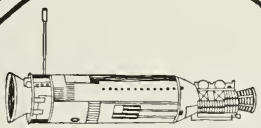

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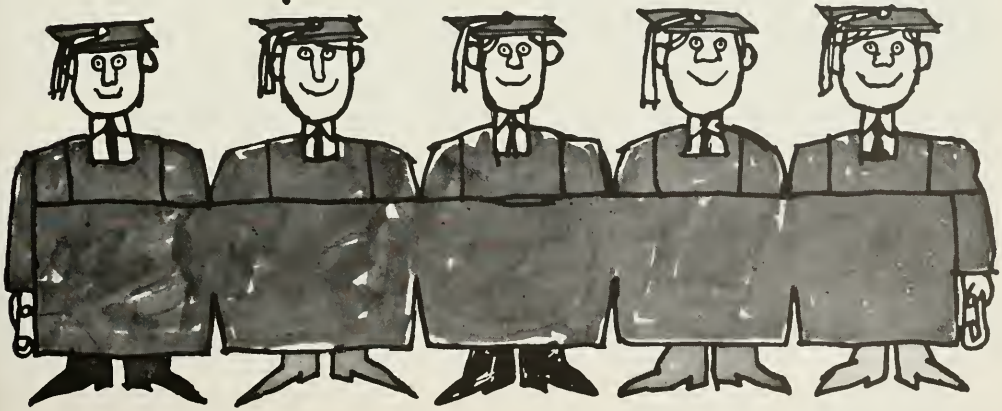


THE HONORS PROGRAM IN PERSPECTIVE

By Alan Halpern and John Bourgoin

Alan Halpern and John Bourgoin, Technograph's roving critics are seniors in electrical engineering. Both are active participants in the Engineering Honors Program. Alan is presently putting the final touches on a special purpose digital computer built in the EE Project lab. John has received a grant from the Bodine Fund and is starting construction of a color organ also in the EE Project lab.

The engineering profession needs scholars — people who have the capacity for self teaching. The James Scholars Program in Engineering strives to produce these engineering scholars. Participation in the program requires a 4.3 grade point average. Presently, there are 366 in the program. The keynote of the Honors Program in Engineering is its flexibility. No one program will be satisfactory to all honors students. To overcome this basic problem, the honors Program assigns to each student a special honors advisor. Every effort is made for the student to keep the same advisor from the time he enters the program until he graduates. Because the program operates with a very minimum of rules and regulations to insure flexibility, all major decisions concerning the student's plan of study and his participation in the program rest with the advisor. Only faculty volunteers who are willing to devote the time necessary to guide a small group of students through their undergraduate years are enlisted as honors advisors.

WHAT CAN THE PROGRAM DO FOR YOU?

The major advantage of the Honors Program is that the honors advisor has the necessary authority to make changes to the student's program which both he and the student deem advantageous. All that is required is that the total number of hours substituted equal the total number of hours replaced in the student's normal curriculum. The criterion for judging the appropriateness of a substitution is that the change results in a more suitable and stronger program for the individual.

A second big advantage of the Honors Program is the privilege of taking special honors courses and the special honors sections offered widely in some departments. The special honors sections are generally taught by some of the best instructors in the department and are not bound to any special syllabus as are the regular sections. Frequently, the honors sections will use a different text than the regular sections. These sections also provide the department an excellent proving ground for experimental offerings of new material and new approaches. The classes are usually much smaller than regular sections and the class atmosphere is less formal than usual. More personal attention is available. The academic atmosphere is more stimulating. Another advantage of the honors sections is that the same group of students usually take advantage of the same sections from year to year. Thus, the honors student gets to know the guys in his classes fairly well. Continuing friendships are much more easily established than in regular sections where one may never see the same person in more than one or two courses.

ACROSS THE DISCIPLINES

At the college level, various interdisciplinary courses are administered along with special seminars and tutorial conferences. These courses are listed in the catalog as variable credit Engineering Honors Courses. Two of the courses are primarily intended to introduce the freshman to the engineering profession and to the roles of the engineer in society. These are restricted enroll-

ment courses taught on a seminar basis by a faculty member with significant professional experience. For juniors or seniors, courses are taught to bring honors students throughout the college together to study interdisciplinary subjects of current interest. Recent courses have studied Systems Engineering, Space Vehicle Design, and the Science of Engineering Materials. The offerings change each semester. As an example, the recent work on Space Vehicle Design, which was focused on the Gemini Vehicle, brought in fifteen speakers from government and various aerospace industries. These speakers, who were directly involved with the Gemini Program, brought to the class real-life engineering problems, many of them involving design decisions which greatly contributed to the success of the course. The current year long Systems Design Project is a team effort considering the problems of the blind. With the students selecting their own leaders along with the project objectives and schedule, the project is a unique undertaking.

Finally, the Honors Program provides seminars within the several departments for the upperclassmen. These seminars are designed to provide the honors students with information on graduate school, research opportunities within the university and up-coming courses.

The Engineering Honors Council, composed of thirteen faculty and three student members has the responsibility of administering the College Honors Program. The duties include the planning of future honors course subjects, the selection of graduating seniors to be awarded "highest honors", and the planning of the Allerton Honors Conference. This two-day conference, held in the spring of the year at Allerton Park, provides a concentrated exposure to a topic not normally covered in classes. The student-faculty interaction during the conference has been a rewarding experience for both students and faculty alike. The topics for the conference have been Direct Energy Conversion and Ocean Engineering. The topic for this year's conference is in the process of being decided.

"It wants a date!"

A CRITICAL VIEW OF THE PROGRAM

There is by no means a consistency in the quality, extent, and interest in the Engineering Honors Program throughout the College of Engineering. The information distributed by the College Honors Council shows that EE offers 11 courses, ME offers 2, CE offers 3, AeroE offers 2, AgE offers 1, and GE offers 1, in addition to 5 courses offered under the heading Engineering Honors. We recognize that it does not pay nor is it practical for many of the smaller departments to offer large numbers of honors courses, but there is no excuse whatsoever as far as mechanical engineering and civil engineering are concerned.

To acquire information for this article, we spoke with many students representing the major departments. From these discussions, a concensus arose which leads us to believe, quite assuredly, that the following results are a reasonably accurate description of the state of the program in the College of Engineering.

ELECTRICAL ENGINEERING

There is little doubt in our minds or those of the students interviewed that the Electrical Engineering Honors Program is by far the best in the college. The program has developed a sequence of laboratory courses designed to teach the theory and practicality of experimentation. They can be taken in place of the customary lab courses. These labs give the student more freedom and more extensive equipment than is found in the regular labs.

The advisors have made the critical assumption that the students are here for the opportunity of educating themselves in the most effective manner for their own individual needs and interests. By assuming this and not destroying the rapport with the belief that the students are trying to "pull the wool over the eyes of the college", they have taken a bold step forward.

One student remarked, "The program has provided the time, academic credit and the opportunity to become involved in research projects and special courses." Another commented that, "The program enables me to make my education mine, not what some bureaucrat thinks it should be. It's the greatest."

MECHANICAL ENGINEERING

The description of the department and the program in Mechanical Engineering were less than complimentary. "A new idea hasn't come out of there since I've been here." lamented one senior. Offering only two courses, one of these being the honors project lab, this department has been painfully remiss in providing the opportunities for which the program was established.

Perhaps the mood of the situation could best be expressed by a comment of an ME student. "It's about time the department came up with a worthwhile honors program. I didn't realize there was any real advantage until I spoke with some of my friends in EE."

CIVIL ENGINEERING

The civil engineering program was best described by one senior in the department: I have been in the Honors Program for three years, and the honors sections I've taken were the most interesting and informative civil engineering courses I've had. But why does the department offer honors sections in only three courses? The consistency of the department's honors advising system also leaves something to be desired. I know of specific cases where one advisor did not hesitate to approve a substitution while another categorically denied the same substitution.

It was the concensus that the department's honors program has possibilities, but as yet it seems to have reached only token implementation.

RECOMMENDATIONS

As a result of our study, we make the following recommendations:

1. The College must demand that those departments which appear negligent in their implementation of their honors program infuse new energy into the program.

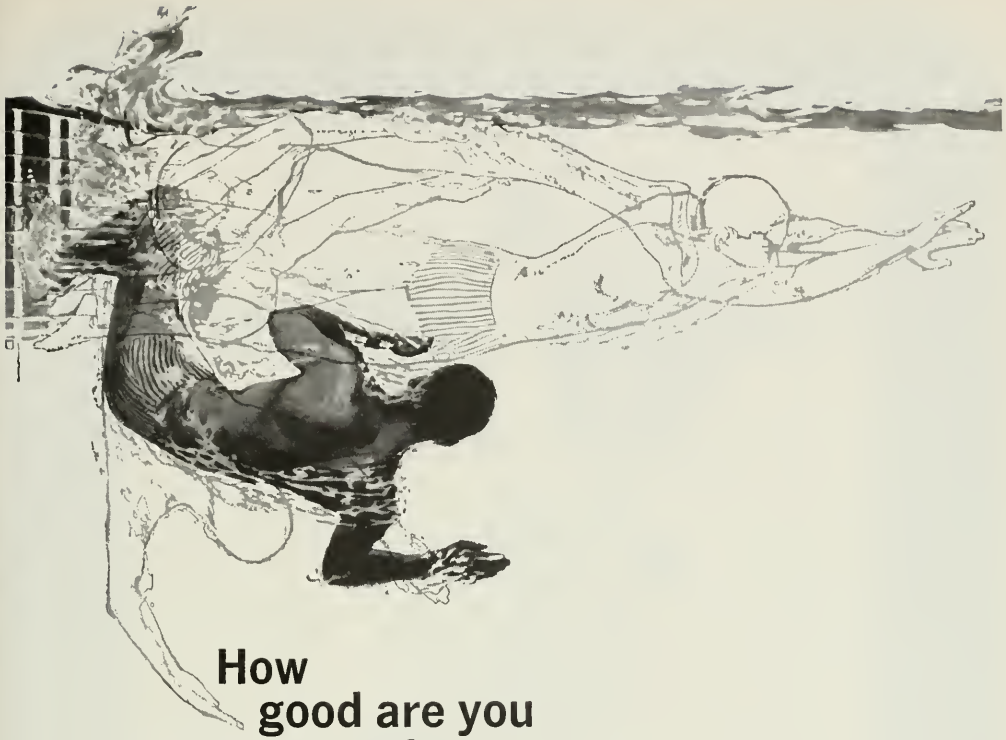
2. Because of the success of the substitution privilege and the gross misuse of the petition system by individual departments, the College should consider giving considerably more discretionary power to the individual advisors, a step which should accomplish significant improvements.

3. The exceptional success of Engineering Honors 196 as a substitute for GE 100 should be clearly demonstrative since GE 100 as it is presently structured will never succeed. The feasibility of a course of this type for all freshmen possibly utilizing talented seniors and graduate students should be considered. In any case, the course should carry 1 or 2 hours credit as does EH 196.

4. The honors program should initiate more experimental courses of an interdisciplinary nature. The Systems Design Project is an excellent first step, but much more is needed. Perhaps, courses could be undertaken to study cybernetics, transportation, air pollution, the systems approach to social problems and urbanization.

5. One of the essentials of the program is student participation, not only in the courses, but in the planning. Academic activism is completely relevant and necessary. Students have a responsibility to inform the department if a course has been bad in the hopes of discontinuance or change; if a course has been particularly valuable, as a stimulus for similar courses and an indication to the instructor of his success, or if a group of students desire a particular course. Students have been somewhat remiss in providing this information, but departments have been irresponsible in failing to solicit and use their ideas.

"It's nice mein herr, but how can I wear my slide rule?"



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Feb. 28, 29, 1968

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February 21 & 22

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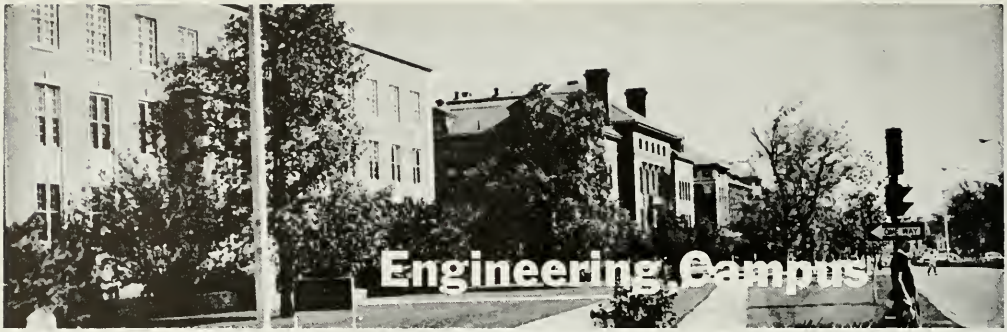

NEW ADDITION TO U. OF I.
CYCLOTRON PLANNED FOR 1968

By John Barra

The University of Illinois cyclotron will get a new feature next year which will increase the precision of the accelerator by four times. The physics department is planning to add an analyzing magnet onto the present model sometime in 1968. The addition of the analyzing magnet will result in an improved energy resolution during the acceleration of various nuclear particles.

The cyclotron, officially known as the Nuclear Research Laboratory, has been in existence at the University of Illinois in one form or another since 1936. In 1936, the University constructed a prototype model of the world's first fixed energy cyclotron in which a beam of particles could be extracted. From this prototype, a full-scale model was built in 1940 and was operated for 18 years.

The 1940 model, however, contained one major drawback as experimentation became more advanced. Because it was a fixed energy machine, the cyclotron could accelerate given particles at only one energy level. This condition provided a limit to the amount and type of experimentation that could be accomplished.

In 1958, Professor James S. Allen, the present director of the Nuclear Research Laboratory, supervised the construction of the first variable energy cyclotron, utilizing the same magnet employed in the 1940 model. This spiral ridge cyclotron contains spiral shims which provided stability in the spiraling orbits of the particles and an aid in the focusing of the beams. Hence, the particles could be accelerated at various energies, allowing more precise experimentation and greater numbers of experiments.

This variable energy cyclotron is presently in operation today. The variable energy range of alpha particles, for example, during acceleration is between four million and fifteen million electron volts. The exact energy at any given acceleration can be measured with the accuracy of plus or minus 80 thousand electron volts. The proposed addition of the analyzing magnet will allow for energy resolution in the vicinity of plus or minus only 20 thousand electron volts.

Presently, experimentation in the cyclotron at the Nuclear Research Laboratory is conducted by the students and staff of the physics department. Six graduate students are currently conducting research projects using the accelerator. These projects involve nuclear spectroscopy, the study of the effective forces within the nucleus. Funds for the maintenance of the cyclotron and the research projects are supplied primarily by the U. S. Office of Naval Research which shows a great interest in experimentation of this nature. The physics department itself is also a financial contributor to the Nuclear Research Laboratory.

How the Cyclotron Works

The cyclotron was first developed because of the growing interest in studying nuclear structures and examining the very minute nuclear particles. A cyclotron has a source of particles which are released and accelerated through a magnetic field. When the particles reach a certain acceleration, they leave the cyclotron through an opening. A beam of these highly accelerated particles can be aimed at an object such as a piece of metal foil. Whenever a particle comes into contact with the nucleus of an atom in the foil, another particle in the nucleus is "kicked out" of that nucleus. Such measurements as energy and mass of these nuclear particles and the number of particles "kicked out" for each particle emitted from the cyclotron can be made.

Most of the particles accelerated in the cyclotron are positive. However, the nucleus which is to be penetrated is likewise positive. Therefore, the particles must be accelerated fast enough to overcome the repulsive

forces of the nucleus (Coulomb's Law). Since the nucleus is so small in relation to the actual size of the atom, only a small percentage of the accelerated particles can collide with it. Consequently, an enormous amount of particles must be emitted in order for a large quantity of collisions to be observed. The present cyclotron at the U. of I. will emit as many as 10 13 particles per second. Finally, the metal foil at which the particles are directed must be thin enough for the particles to pass through without losing a great deal of energy. The foil which is used can be made to be as thin as one one hundred-thousandths of an inch. However, particles with exceptionally high energy have been known to penetrate as much as one millimeter of an object.

NEW OPPORTUNITIES FOR UNDERGRADS IN E.E.

by Fred Jaeger

The scope of the Electrical Engineering Department is so large that few undergraduates have the opportunity to discover all of its fields. New and exciting courses are still being added to make the department even more encompassing. Areas that were recently open only to pure research, and perhaps graduate study, have now filtered down to undergraduates. Students particularly interested in these "new" areas may now get a glimpse of them at the undergraduate level.

One new area for advanced undergraduate study is Quantum Electronics. The Quantum Electronics field centers around the development of the laser which has become an important source of electromagnetic waves. Ever since C. H. Townes thought of resonating the radiation of atoms to produce coherent emissions, lasers have undergone tremendous research and development. Many types of lasers have arisen from the basic laser principle. Atoms are excited in a long, narrow column with mirrors at both ends. One of these mirrors is partially transparent. Only that emission which is traveling perpendicular to the mirrors and is in line with the length of the enclosed column will be reflected back and forth, building up a high energy density. Some of this energy escapes through the partially transparent mirror. The result is a coherent, monochromatic beam of light.

The research being done with lasers includes rapid heating, radiation effects on materials, holography (three dimensional photography), communication uses (including modulation and demodulation at laser frequencies), and the study of scattering, wave interference, and pology. One can easily see the potential of quantum electronics.

Now, a Quantum Electronics Project course as well as an introductory course in Quantum Electronics is being offered at the University of Illinois. This is quite an achievement, considering the first laser was built in 1960. Prof. N. Holonyak, Jr. instituted EE 387, Introduction to Quantum Electronics. Prof. H. Merkelo, with the backing of the National Science Foundation and the entire Electrical Engineering staff, was the chief driving force behind the development of the Quantum Electronics Projects course here. Prof. Merkelo supervises the projects and teaches EE 271, Projects and Lectures in Quantum Electronics. Lectures are given at the beginning of the semester, and each student chooses a project. As the course proceeds, the student works on his project, doing research on his own. Later in the course, Prof. Merkelo continues with his lectures and the students also lecture on their individual projects. Throughout the course, individual research and planning is emphasized.

WILLIS NAMED TAU BETA PI'S OUTSTANDING FRESHMAN

By Don Hanson

Jeffrey O. Willis was recognized as the "Outstanding Freshman in Engineering" at the Tau Beta Pi fall initiation banquet of December 15. Dean William L. Everitt introduced Jeff and presented him with a certificate, the *Handbook of Chemistry and Physics,* and the *Feynman Lectures on Physics.*

Tau Beta Pi is a distinguished national engineering honorary. As such, it seeks to encourage academic excellence and a spirit of liberal culture among engineering students and professionals.

Implementing its ideals, the Illinois Alpha Chapter annually appoints a committee to designate the outstanding freshman engineering student of the previous year. The committee selected Jeff Willis for the award, which is based on academic record and a personal interview.

Mr. Willis lived in Mount Prospect, Illinois, before moving to New Jersey, where he was valedictorian of a class of 575 at Bloomfield High School. Upon entering the University of Illinois Jeff proficiencied rhetoric 101 and continued to excel throughout the year by earning a near perfect A average. He is majoring in engineering physics and hopes to go into research in that field. His hobbies include music, photography, and fencing.

At its fall banquet Tau Beta Pi initiated thirty-five pledges. To be nominated for membership a first semester junior must have at least a 4.75 grade point average and be of unquestionable character. The grade point requirement is progressively lower for advanced students. All nominees are required to write a pledge essay, the best of which is selected for a national contest by Professor McClintock of general engineering. After reviewing the essays of the fall 1967 pledge class, Professor McClintock spoke in glowing terms of the engineering students new sense of social responsibility. The essays dealt with such topics as "The Engineer in Public Affairs," "The Engineer as a Conservationist," and "The Effects of Technology on People and their Environment."

SYMBOL DEPLETION

We've almost lost a good word, and we hate to see it go.

The movie industry may feel the same way about words such as colossal, gigantic, sensational and history-making. They're good words—good symbols. But they've been overused, and we tend to pay them little heed. Their effectiveness as symbols is being depleted.

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February 19

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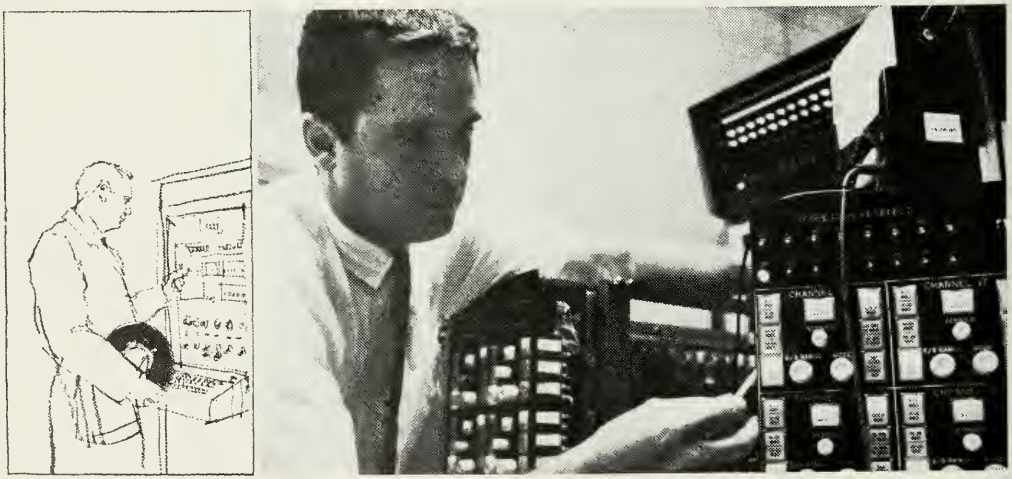

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GENERAL ELECTRIC

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MARCH 1968

TECHNOGRAPH

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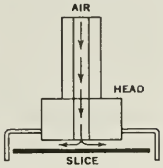

Picking something up by blowing a stream of air down on it may seem rather roundabout. But if you want to pick that something up without touching it, it turns out to be a most successful way.

The something in question is a paper-thin, eggshell-fragile slice of silicon destined for transistors. To touch it is likely to contaminate it, and probably to break it. Tweezers are extremely risky. Even a vacuum pickup is dangerous.

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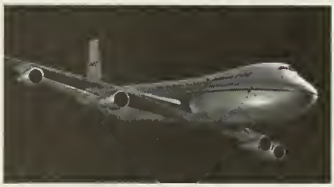

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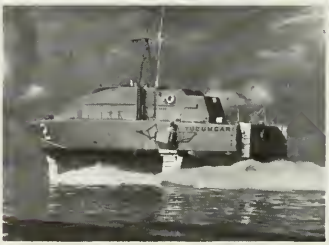

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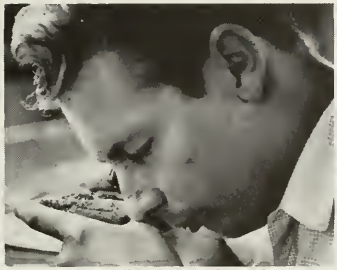

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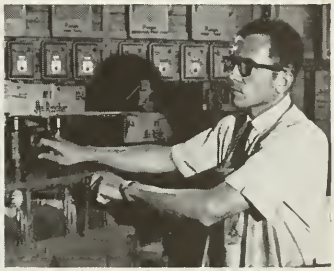

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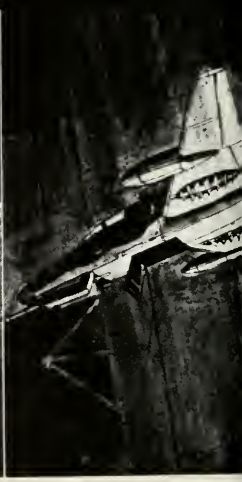

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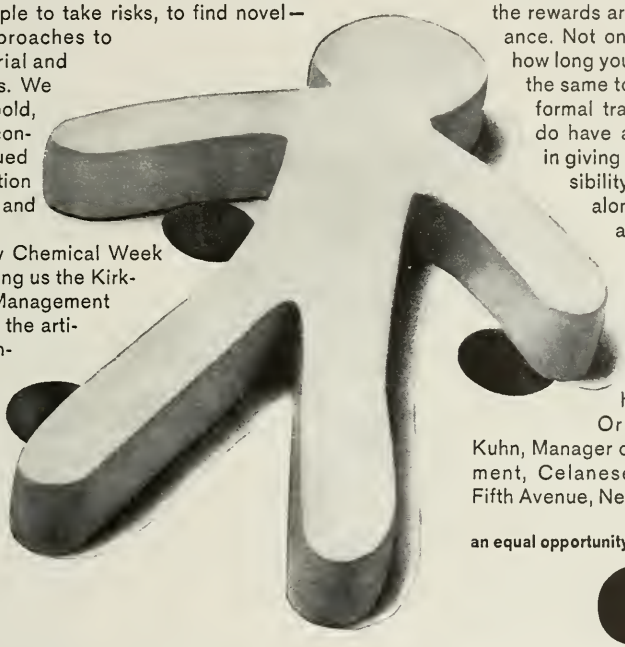

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COVER

Twenty-five years ago Enrico Fermi established the first nuclear reaction at the University of Chicago. To commemorate the anniversary Henry Moore unveiled the 12-foot-high bronze statue of "Nuclear Energy" which marks the original site.

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THE NUCLEAR POWERED FOOD FACTORY

"apollo of the 1970's"

by Donald A. Hanson

Donald Hanson is a third year electrical engineering major who hails from Glen Ellyn. He is actively involved in IEEE, Tau Beta Pi, Eta Kappa Nu, and the college honors council.

"Today twelve thousand people died of hunger in the world. Tomorrow another twelve thousand will die." [1]

These deaths are merely a warning of unprecedented famines whose horror may shake the undeveloped countries to their roots. These deaths are a warning whistle of the locomotive barreling down upon us, which William and Paul Paddock describe in *Famine — 1975! America's Decision: Who Will Survive?*

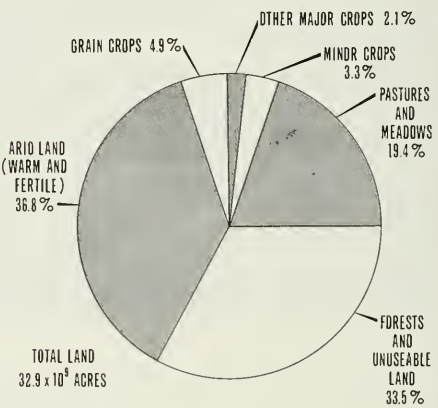
> A locomotive is roaring full throttle down the track. Just around the bend an impenetrable mudslide has oozed across the track. There it lies, inert, static, deadly. [2]

The locomotive is the unchecked population explosion which is rampaging through the earth's food supply. The treacherous landslide is the stagnant production of food in the developing countries where the population increases are the most serious. Paddock systematically analyzes the technologies which might be employed to avert the famines. However, the momentum inherent in agricultural production is far too great to permit rapid change. "The collision is inevitable. The famines are inevitable." [3]

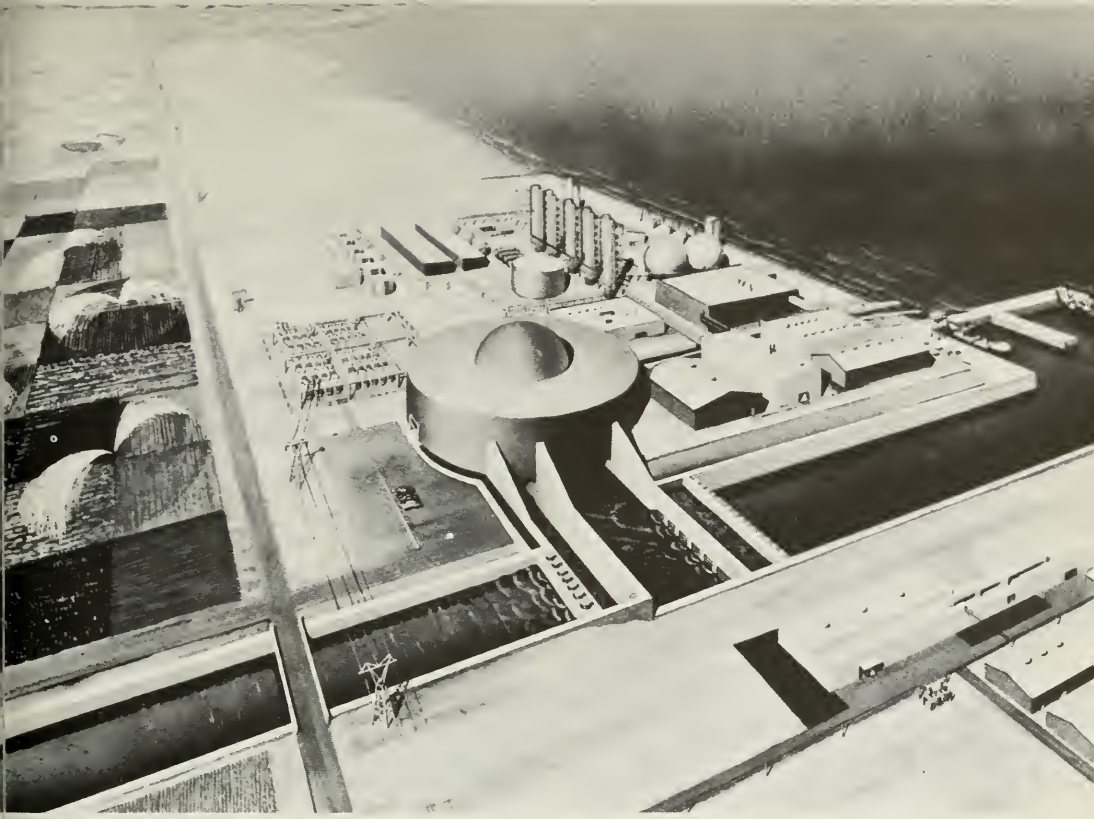
Ironically, some men are still the slaves of nature in their primitive struggle to feed themselves, while others are the conquerers of even nature's powerful nuclear forces. Attempting to resolve this paradox, Alvin M. Weinberg, Director of Oak Ridge National Laboratory, envisages what he calls the nuclear powered agro-industrial complex. [4] Yet realizing this conception will challenge to the utmost both man's ability to develop technology and his perseverance to apply it to one of the gravest social problems of our time.

THE EXOTIC FOOD FACTORY

The nature of the nuclear powered agro-industrial complex is basically this: Employing advanced breeder reactors (much larger and more sophisticated than are in operation today), the sea can be desalted or deep reservoirs of water can be tapped to irrigate previously unproductive arid land. The by-product electricity generated by the reactor can be used for industrial processes such as the electrolytic formation of hydrogen, which in turn can be used to produce ammonia fertilizer. On site laboratories will investigate the optimum quantities and times for applying water, fertilizer, and pest control chemicals. High-yield grain crops will be planted in blocks at least twice a year according to regular schedules. With continuous production, at any given time certain blocks will be in the process of being planted, others fertilized, many watered, and some harvested. Thus the agro-industrial complex is a highly regulated, rational approach to agriculture which can appropriately be dubbed as an exotic "food factory." [5]



R. Philip Hammond, Director of the Oak Ridge National Laboratory Nuclear Desalination Program, uses this chart to illustrate the abundance of fertile arid land.



The artist's conception of a coastal desert food factory shows a large nuclear reactor for desalting the sea and generating electricity. In addition to supplying fresh water for irrigation, the reactor could be the nucleus of an industrial complex. Installations of this type may in the future feed millions of people.

WHEAT BLOWING IN THE DESERT WIND

There are good reasons for believing in the potential value of such food factories. Since the agriculture will be extremely well regulated, the crop yields will likely be close to their genetic potential. Recently, great success has been obtained in developing new varieties of wheat, corn, and rice. For example, the use of new short-stemmed, rust resistant, high-yielding varieties of wheat has converted Mexico from an importer to an exporter of wheat.

There are also great possibilities for the sunny deserts. A desert irrigated by a river is among the most productive land available. Recall that the four ancient civilizations sprang up along the Nile, the Indus, the Tigris-Euphrates, and the Yellow rivers. By irrigation these peoples were able to stabilize their agriculture and hence their way of life.

Today there is no shortage of deserts, but there is a shortage of rivers to water them. R. Philip Hammond, who directs the desalination program at Oak Ridge National Laboratory, summarizes his belief in the potential of the deserts:

> According to UNESCO, the supply of warm, fertile, accessible arid land exceeds several fold the total land now used for our major food crops. Less than a fifth of our food crop land is presently irrigated. Yet this portion produces the majority of crops. More than a third of all arid land is close enough to the sea to be irrigated from that source. [6]

Thus food factories strategically placed along the potentially fertile, coastal desert regions in the Middle East, Latin America, Australia, and India could supply the basic foodstuffs for millions of people.

"THE IMMACULATE PRINCIPLE"

The technology required to irrigate vast areas of desert using sea water must at best be considered formidable. The primary task at hand is the development of the advanced breeder reactor. Yet nuclear technology is an infant. Just twenty-five years ago

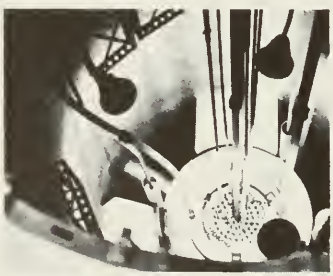
Enrico Fermi established the first nuclear chain reaction at the University of Chicago (the sculpture on the cover commemorates this event)[7] Now the time schedules have been compressed. Developing the advanced breeder is according to *Fortune* magazine "almost as though jet engines were under test and supersonic transports sketched out before (Lindbergh's) Lone Eagle left New York."[8] Yet the fast pace is well worth the effort as *Fortune* vividly describes:

> Today's nuclear reactors are substitutes, used because they provide heat at less cost than coal or oil. Tomorrow's machines are the instruments of revolution. Some of them, called breeder reactors, will create more nuclear fuel than they burn. The implications of this seeming reversal of the laws of nature are such that the alchemists' dream of changing lead to gold can be regarded as a petty aspiration. The breeders promise to deliver vast quantities of energy at such low cost that they will have a cascading effect on all industry, on man's efforts to gather food and build shelter, and on the fabric of society itself. Scientists and technicians, in a frustrating search for some way to describe the changes that their work portends, speak glowingly of air-conditioning Africa and heating the subarctic.[9]

No less grandiose are the dreams to reverse the natural course of rivers so that fresh water will flow back from the sea into the deserts.

To the scientist the concept of the breeder reactor is "an immaculate principle."[10] The fuel rods contain radioactive plutonium (Pu239) and stable uranium (U238). During nuclear fission a neutron will split a Pu239 atom, which will release energy and several other neutrons to continue the chain reaction. However, a neutron striking a U238 atom will be absorbed, creating a new Pu239 atom. In an advanced breeder about three Pu239 atoms will be formed for every two destroyed.

Yet applying this principle is a "mechanical engineer's nightmare."[11] Requiring a sophisticated cooling method, most breeder designs include streams of liquid sodium, a tricky substance that will burst into flame when exposed to water and will corrode most metals when contaminated with oxygen. Furthermore, "fast" breeder reactors, with neutrons traveling at speeds of 10^7 mph, are difficult to control.



The University of Illinois does nuclear engineering research with its TRIGA reactor. The power reactors of the future will be of much greater scale.

By comparison today's conventional reactors are safe, reliable items of commerce. They are cooled by either pressurized or boiling water. This coolant also acts as a moderator to slow the neutrons down to "thermal" speeds by molecular collisions. Although these reactors are highly competitive with fossil fuels, they have rather poor thermal and fuel efficiencies.

The TRIGA reactor has a circular array of fuel elements inside its core. At full power the core is illuminated with the blue-green glow of Cerenkov electron radiation.

THE ECONOMICS OF SURVIVAL

Completely interwoven with the requirements of exotic technology for the nuclear powered agro-industrial complex is the consideration of economic feasibility. People in developing countries cannot buy food they cannot afford.

Obviously water will be a precious item in the complex. Using today's technology of desalination, the Metropolitan Water District dual-purpose plant in Los Angeles is expected to produce water at about 22¢/1000 gallons and electricity at about 2.7 mills/kwh. Fortunately, this technology is progressing at a rapid rate so that, with a cheap energy source, water could be made available for irrigation at a few pennies per person per day.[12]

As the price of energy drops, the number of heavy chemical processes, which can competitively use this clean energy as its ultimate raw material, increases

rapidly. The profit gained by the industrial aspect of the complex will substantially increase the attractiveness of the food factory venture. Furthermore, it will provide jobs for many people and stimulate regional development in the entire complex vicinity. Hence, the motivation for developing that extremely cheap source of energy, the advanced breeder reactor, is great.

Complexes powered by advanced breeder reactors must be considered "long term" projects. However, even the "near term" complexes powered by present day reactors appear surprisingly attractive. The details of a near term complex were studied during the summer of 1967. [13]

> A variety of crops would be grown on 140,000 acres of irrigated desert. Ammonia, phosphorous..., chlorine, and salt would be manufactured. The total investment (including a 2000 Mw-electrical reactor and a 500 million gallons per day desalting plant) comes to about $900 million. The annual value of products produced is $330 million, of which $100 million are agricultural products. The profit on the venture is computed to be $136 million per year, or 15% of the capital investment. [14]

"THE APOLLO OF THE 1970'S"

The plans for the future, however, are far more grandiose. On the twenty-fifth anniversary of controlled nuclear energy, Alvin Weinberg speculated with his fellow scientists on the social impact of their work. As an example he mentioned the Uttar Pradesh of India with its vast resources of ground water. Using the breeder reactor to pump water up from the ground and into the far off fields of the food factories, Weinberg speculated that this Indian province "could increase its food production at least four-fold and possibly twice that. Now... if the scheme were extended to include the entire Ganges Basin... India, at present the importer of $6 billion dollars worth of food annually, could become an exporter of food!" [15]

Alvin M. Weinberg, Director of Oak Ridge National Laboratory, is one of the founding fathers of controlled nuclear energy. He is presently concerned with developing the advanced breeder reactor which could revolutionize man's ability to gather food.

The task ahead, toward realizing such a dream, is a difficult one, but the stakes are high. If in the future the famines, which threaten to ravage the developing countries, are to be prevented, then developments such as the nuclear powered agro-industrial complex must be immediately pursued with the same enthusiasm and effort so characteristic of the Apollo space mission. Weinberg concludes, "I would certainly hope that out of studies such as this would come some sensible project that could... capture the imagination of a war-weary world." [16]

ACKNOWLEDGEMENTS

The author wishes to thank Dr. Alvin Weinberg for supplying the materials upon which most of this article is based.

The picture of "Nuclear Energy" shown on the front cover was donated by the Editor of *Argonne News*, Argonne National Laboratory.

FOOTNOTES

1 Rep. Harold D. Colley, as quoted by Felix Belair, Jr., **New York Times**, February 23, 1966, as quoted by Paddock, **Famine-1975!**, p. 11.

2 William and Paul Paddock, **Famine-1975! America's Decision: Who Will Survive?** (Boston: Little, Brown, and Company, 1967) p. 9. This highly readable, poignant book concludes with a surprising suggestion for American foreign policy in times of food crises.

3 **Ibid.**

4 Alvin M. Weinberg, "The Coming Age of Nuclear Energy," a presentation before the Eleventh Session, General Conference of the International Atomic Energy Agency, Vienna, September 28, 1967, and "The Nuclear Powered Agro-Industrial Complex," a presentation before the Foreign Relations Committee, United States Senate, Washington, D. C., October 19, 1967.

5 R. Philip Hammond, "Desalted Water for Agriculture, "**Review**, Oak Ridge National Laboratory, Summer, 1967.

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7 "Moore Sculpture Commemorates The Day," **Argonne News**, Argonne National Laboratory, December-January, 1968.

8 "The Next Step Is the Breeder Reactor," **Fortune**, March, 1967, p. 121.

9 **Ibid.**

10 **Ibid.**

11 **Ibid.**, quoted from an anonymous reactor manufacturer.

12 Weinberg.

13 The study of the complexes was conducted at Oak Ridge National Laboratory under the guidance of Professor E. A. Mason of Massachusetts Institute of Technology. Weinberg discusses the conclusions.

14 Weinberg.

15 Weinberg as delivered at the University of Chicago on December 2, 1967 and reported in **Argonne News**, January, 1968.

16 Weinberg. The subtitle "Apollo of the 1970's" was used by Weinberg in his address to the AMU conference on nuclear engineering held at Argonne National Laboratory, August, 1967.

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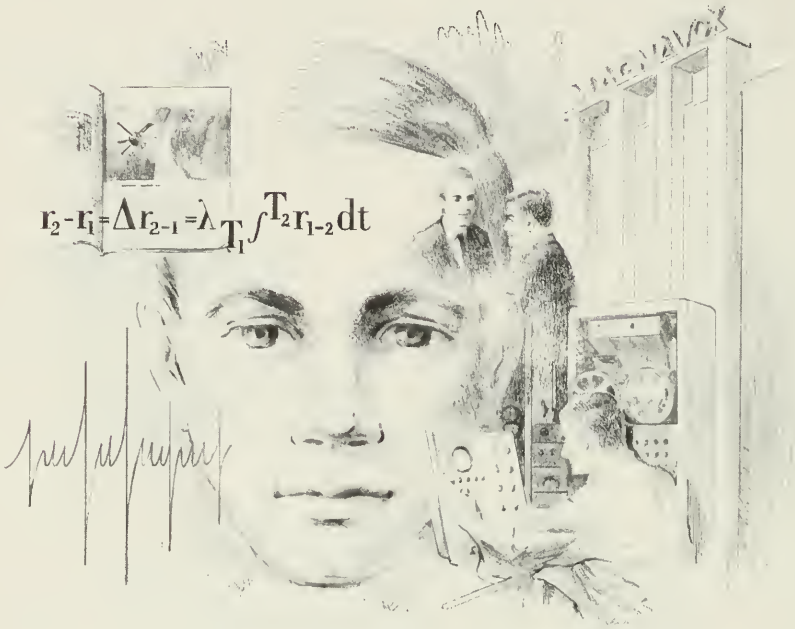

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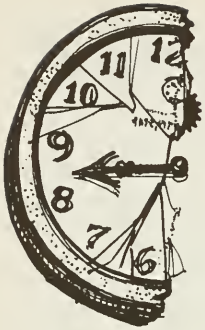
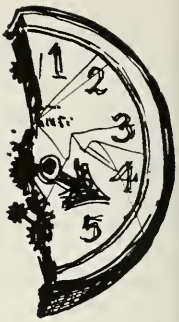


by Edwin Black

SIXTY YEARS BACK...



SIXTY YEARS FROM TOMORROW

Edwin Black, freshman English major, enjoys writing both non-fiction and creative articles.

The winter snow had given him very little difficulty. He had seen ninety-two winters before this one when he walked over a mile in the sub-zero January cold to our interview at the Illini Union. He introduced himself at the place we were to meet. "Hello, I'm Ellery Paine. I hope I'm not late." "Only five minutes," I said. "Well, I've been alive ninety-two years now and I guess five minutes isn't too bad." He sat down and checked the time on a watch two hundred years old his father had given him. "You want me to talk about the College of Engineering. Well, I've been with it for sixty years now. I was born in Connecticut in 1875. I remember a lot of things about the University of Illinois. I came here in 1907..."

Ellery Paine came here in 1907 from a small eastern institution where he was professor of electrical engineering. To satisfy his wife, who disliked the area, he moved. "The University of Illinois seemed to be a place that was on the rise and I thought I would have a future there." But Ellery had to enter as an assistant professor, "...one step down in rank, but I made my wife happy."

In 1909 Paine became the acting head of the Electrical Engineering Department. He held the post for six months when it was awarded to Ernst Berg. Berg resigned in 1913 and Paine took his place, maintaining the office for thirty-one years until his retirement as Professor Emeritus. A man called Everitt took his place.

When we toured the Engineering Campus it was so cold the chemicals in our photographer's polaroid froze; it didn't bother Ellery who insisted on staying outside describing points of memory. "I remember the year this honorary key was..."

It was a little after Ellery retired as department head that Tau Beta Pi presented the honorary key to the College of Engineering. Going further back Ellery recalls the old Electrical Engineering Building. It has since been remodeled and is known as the Electrical Engineering Research Laboratory. "I had an office up there. It was under the attic and I had a clear view of the boneyard from my window. I never used the office much, but one of the times I did I saw some fraternity

Edwin Black talks with Ellery Paine in Illini Union.

pledge jump right into the boneyard water. When he came out you could smell him a quarter of a mile away."

Inside Engineering Hall Ellery remembers one of his favorite classrooms. It was 106 Engineering Hall. "I used to teach there for years. But a while back they had a Dean who didn't like walking upstairs where the old Dean's office was." Ellery's classroom was changed to a Dean's office. "Now it's Dean Everitt's office. It's on the first floor so the Deans don't have to walk so much now."

The students and staff of the Electrical Engineering Department pose during the spring of 1911 on the steps of what was the Electrical Engineering Building.

"I never had Dean Everitt as a student but I had some of the other members of the staff. Miller, Martin, Fett, they were all my students. "I could tell you some things about some of my students...!

One of Ellery's students was a bright boy but could not concentrate on his assignments and was contemplating leaving the field of engineering. "I gave him some advice on concentrating and apparently he was a success. Later he became the President of the Carnegie Institute." Ellery remembers one student in particular that never wanted to do any work, "But what he did do was outstanding. I always complimented his intelligence if only he could apply it more often." The student did and became the President of U.S. Steel Corporation.

"I had one student who was really a smart chap..." He used to sit and dream in class. He kept saying he was waiting for a time, a right time, and then he would show everybody! When the Depression came and everything was as cheap as could be he took his life savings and bought an entire factory. Applying a process he developed he mass manufactured his own invention at a fraction of the cost during other times. The *microswitch*, his invention, has become today one of the most essential parts of any automation system. "And he did show everybody. He became the success he said he would. Students are really all the same, if you look at them sixty years ago or sixty years ahead. There are problems and..."

Sixty years back the Electrical Engineering department was a small group of men and not even one woman. When Paine retired the staff only numbered thirty-five. Great leaps of progress have ameliorated this condition. Today the staff includes 280 men and women. The subjects are much more diverse today than they were sixty years back when no one could possibly imagine professors of biology or astronomy in the College of Engineering. Students then were faced with essentially the same problems if not more than students of today. They are usually arduous and conscientious. Engineering students today "...are not 'social flunk-outs.' They are no different from the fellows I taught over a half-century ago."

Speaking about engineering students in relation to their fellow university students Ellery Paine said this. "Today's boys like yesterday's boys merely follow their own interest. They fall under criticism because they don't argue like students of other colleges do. An intelligent engineer knows arguments don't get anywhere. When engineers have a difference of opinion it can be tested in the lab and you can see and touch the solution. Verbal arguments can't be won. Especially if both parties are stubborn does this apply." When asked: doesn't this make the engineering student a lot too scientific and a little too human, Ellery replied, "He's of course very human. He's like anyone else, a specialist. If he wasn't a specialist he couldn't function the way he does and our society would stand dormant."

Above is the Electrical Engineering Building in 1911. Parked in front of it is Ernst Bert, Ellery Paine's predecessor as the head of the Electrical Engineering Department.

Ellery Paine, himself, has two government patents on methods of testing high voltage cables but he says the greatest scientific experiment he ever participated in tested an invention by someone else. "Professor Tykociner asked me to assist in the experiment because..."

Because an important professor left his position at the university to work for Westinghouse Corporation, an essential opening in the electrical engineering department had to be filled immediately. Paine offered the job to a young refugee from the Russian Revolution. His name was Tykociner. Paine recognized him as a genius. Very soon after Tykociner's arrival at the University of Illinois he revealed a wild scheme that nearly everyone thought was absurd, except Ellery Paine. Paine aided Tykociner in his experiments for months. At last it was achieved; Tykociner had succeeded in making a motion picture film with sound. "And Tykociner asked me to make the first sound-on-film recording, the first sound movie star you might say. Not knowing what to say I said the first thing that came into my head: 'Four score and seven years ago...' " They wrote letters of solicitation to Hollywood but were merely scorned. "They said the sound-on-film process would ruin the movie industry. Then a man called Eastman bought the invention. He later developed the Eastman-Kodak Co."

Paine points to a display about the first sound film and repeats the very words he used for the first sound-on-film recording: Four score and seven years ago...

Walking by the research laboratories Paine recalled the difficulties of research. "The problem was we had no money. Today the faculty places more emphasis on research than they did when I was department head. Now we have all the money we need. There are all kinds of grants from all different sorts of places for fantastic sums that go into hundreds of thousand of dollars."

When asked what he thought of the notion that today's faculty isn't as concerned with the students as the faculty was a half-century ago Ellery commented: "Hogwash!" Expounding on his articulate response, Paine said: "There has always been a great interest in the young men. The faculty has always actively helped the students in any way they can. Sixty years ago it was the same. We took an interest in our students. I wouldn't have become a teacher if that was not the case. There has always been a great deal of guidance and I think there always will be. It is one of the attachments of the profession. As long as there are teachers the student can feel someone takes an interest in him."

When asked if he thought the College of Engineering lacked or needed anything Ellery laughed and said, "Well now, they have just marvelous teachers; they always had them but now there are more of them. The facilities are just improved 200%. If today's students only knew how hard it was to get many things done then, they might not take many things for granted. Today we have equipment that we could never afford before; our government has given us a great boost there. We have the facilities to carry on our work that we never had before; and it's not just engineering I'm talking about here. It's any student at this university, no matter what field. All you have to do is look around and you'll see some new building or another going up."

I asked him what he saw in store for the future after seeing what was in store for the last ninety-two years. "Well now, as you know the societies are ever-changing," he answered. "I have seen the changes having been alive almost a century. I've taken part in some of the changes personally. And I think that, in the majority, these changes are due to engineering and scientific technological advance. And I think that it is the engineer's responsibility to supply the advance that enables the world to progress." I interrupted, "But doesn't some of the 'progress' actually serve to defeat and ruin society? Can you think of any technological 'advances' man could have done without?"

"Social problems are not our field," he immediately replied. "We deal in ideas and progress, and we do it. We give this to mankind and put it at his disposal. He does with it as he chooses. Let the sociologist work out the social problems. But this is not to say that we are not conscious of society or its problems. Even

myself, my greatest joy aside from watching my grandchildren grow is watching my former students and examining how they have affected the world. Students like the ones I mentioned or some I didn't mention. That is my satisfaction as a teacher. My greatest satisfaction as an engineer is to see the results of the progress we have presented mankind with, whether I helped with it or not."

As we walked back to the Illini Union I thanked him for his time. I said, "Is there anything at all you would like to add, sir?" "Can I say anything I want?" "Anything," I said. "Well now, it's this one thing that concerns me and you, too. I'm an engineer and I have seen the relationship between man and his world. I have lived a long, long time. I have seen a lot of people and lot of things in that time. There is one advance that man can make that would equal all the technological progress you can imagine. And that is for the black man and the white man to live together without hostility or hate..."

He said that there was hostility between the races sixty years back and man had not advanced since that time. He said he saw it at this university when he came here in 1907 and he sees it still today. "It's a disgrace to mankind's intelligence to see one man hated by another for no other reason than color, especially at a place like this that boast logic and reason. I see it on the engineering campus as well as the other campuses on the university here." It is deplorable that man has learned to live with the most inhuman elements of Nature, but has not even learned to live with his fellow man. "After sixty years here," he said, "after ninety-two years of life," he said, "this is the area that I think man needs progress in most — and it won't come about as a result of technological advance; there is no machine we can invent that can bring it about" He turned up his collar when the gusts of wind were too much for that cold day. That was Ellery Paine's picture sixty years back from today... sixty years from tomorrow he hopes the picture will be different. "If you want to print my last words to you, print these: Men can't go anywhere without each other." He walked away back into the cold, refusing to let the freezing wind bother him.

Ellery Paine, Professor Emeritus, stands proudly at 92 years of age.

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THE ST. PAT TRADITION...

in the beginning

The remarkable discovery that St. Patrick was an engineer was made by a group of engineering students at the University of Missouri in March, 1903 or 1904, depending on which account one believes. Out of this discovery has grown the St. Pat tradition. The celebration which began as an unscheduled student frolic has become, over the years, an elaborate program of events in the course of which old Saint Patrick himself appears to dub certain of his devotees "Knights of Saint Patrick" and to crown a local coed as Queen for the ensuing year.

The first published record concerning St. Patrick the engineer appeared in the University of Missouri *Daily Tribune* on March 17, 1903. In an article entitled "In Memory of St. Patrick" it is stated that the following resolutions were adopted by the engineering classes of the University:

> Whereas, It has been the custom of certain uniformed ministers of the gospel to declare at various times the practices and beliefs of our worthy St. Patrick, it was deemed advisable that the question of his origin and life should be definitely and forever settled, and
>
> Whereas, In order to set at rest all controversy upon this subject an investigation by eminent authorities was set on foot, and
>
> Whereas, The investigation has proved eminently successful the result of which was to establish beyond any doubt of council that St. Patrick was an engineer,
>
> It is therefore
>
> Resolved, That every engineer, senior, junior, sophomore, and freshman, do each year on the day of St. Patrick refrain from all duties and attendance upon classes and spend the day in observing the memory of our pioneer brother,
>
> It is therefore
>
> Resolved, That each year in the Department of Engineering, on the day of St. Patrick a holiday is declared. Signed: Senior, Junior, Sophomore, Freshman.

The 1903 issue of the Missouri *Savitar* carries this record by one "Leto:"

> As for the 17th, upon examination of the Erse Chronicles by Rooney-the-Mick, the following note was found: "Erin Go Bragh," which translated into English means "St. Patrick was an Engineer."[1] Assisted by the band the engineers took the day off, and the Engineering Profs. took a grade or two off.

by Curt Wrechert

Another account supporting 1903 as the founding year was given by Omer Denny who graduated from the University of Missouri in 1904:

> On a warm spring day in 1903, a small group of students of the classes of 1903 and '04 were in the Engineering Library, ostensibly for the purpose of study. It was the time of year for spring fever and in this group it had reached epidemic stage. I cannot recall the names of all these students but someone expressed the necessity of a holiday, and since St. Pat's day was near at hand it was chosen as the day.

A final account in defense of '03 was given by Lee Elmer Philbrook of the class of 1904.

> We were all inclined to have spring fever and wishing for a holiday. There was no holiday near, the only day of special consequence was St. Patrick's day and that was not a recognized holiday. Someone said that St. Patrick was an engineer and proceeded to prove it mathematically. I believe he set it up in the order of a theorem in geometry and I am quite sure it ended with Q.E.D. We were all agreed that the proof was mathematically correct and that we should celebrate his birthday by taking a holiday.

1 "Erin Go Bragh," is actually an old Irish battle cry meaning, "Ireland Forever."

The case supporting 1904 as the founding of the engineer's celebration of St. Pat's day is not so well documented. But Charles K. Martin of the class of 1905 has given this stirring account:

> Homer Haggard was quite a popular student in school. He was on the football team and either in 1904 or 1905 he was captain on the team, and being red-headed and with an Irish disposition, he was one of the fellows that you like to kid. Dr. Stewart began by asking Mr. Haggard why he was in class on a day like that, and Homer asked him why he asked that question, and his reply was something like this, "You are Irish, aren't you, and this is the seventeenth of March. Didn't you know that St. Patrick was an engineer?" Homer asked him how come and Dr. Stewart replied, "Didn't he engineer the snakes out of Ireland?"; then Dr. Stewart continued, "You fellows ought to take a holiday and celebrate the occasion."

One strange detail of this account is the fact that Homer Haggard has no recollection of this incident.

Regardless of the date of the actual beginning of the engineer's celebration of St. Pat's day, the truth about St. Patrick is that he was probably born in what is now northern France. His first visit to Erin was evidently about 400 A.D., as a captain of a band of Irish raiders. He was sold into servitude in Erin and remained there for six years. Not strange it was that he then heard, as he slept one night, a voice ordering him to escape from his master. This he did and made his way home to northern Gaul, performing a few miracles along the way. In his homeland he became a monk and was, it is said, trained by some of the notable saints of the period. He traveled about Europe, ever increasing in sanctity and learning, often hearing the admonition of angels and occasionally tossing off a miracle, or so the story runs. Eventually he was ordained as a bishop, and presumably, on this occasion received the name Patricious. Meanwhile the future Saint had decided to return to the island of his early captivity as an apostle to the pagan Irish. This he was able to do in 432 A.D., with papal authorization. At this time Patricious was about 44 years of age. His great work in Ireland during the remainder of his life has been told and retold many times, and records or legends link his name with hundreds of places in his adopted land. The evidence is that he was a powerful preacher, an excellent organizer, and a devout worker in the Church.

The knighting of certain students and St. Pat's Ball were natural outgrowths of the engineers celebration of St. Pat's day. Since 1906, when all graduating engineering students at the University of Missouri were named Knights of St. Pat, many different ceremonies and requirements for knighthood have been developed on engineering campuses across the nation. And St. Pat's Ball is a yearly occurrence on almost every engineering campus.

The beginnings of the engineering St. Pat tradition are indeed humble, but they cannot be described as uninteresting. No matter whose description of the beginning one chooses to believe, the origin of the tradition is almost as much a legend as St. Patrick himself.

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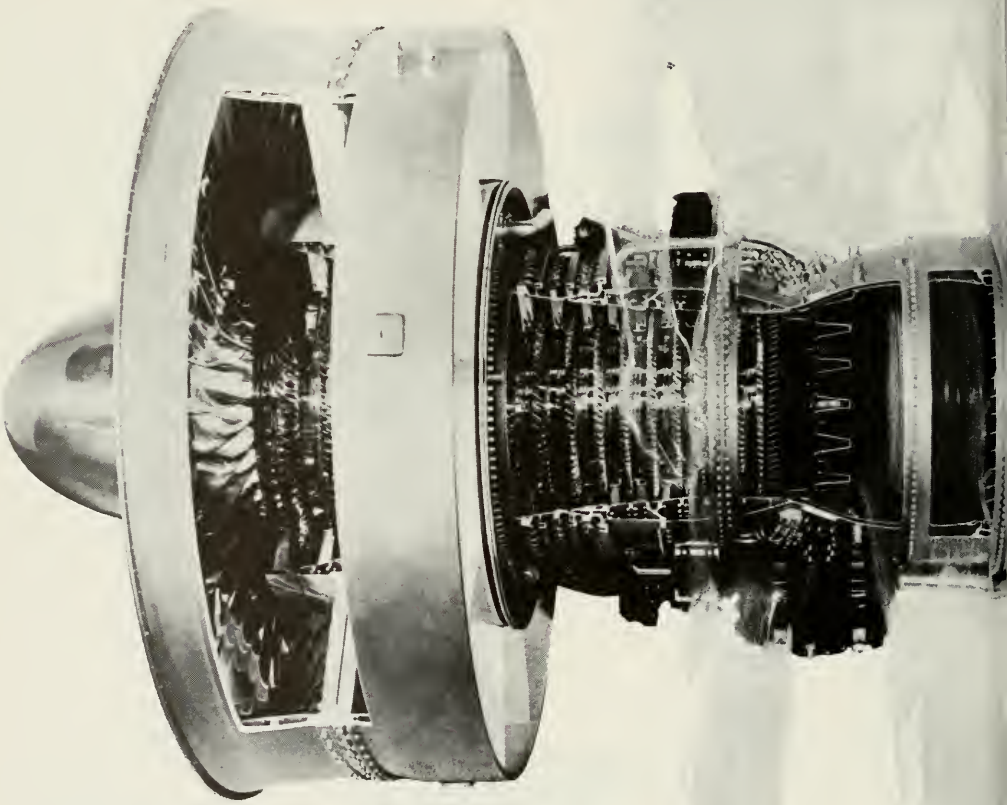

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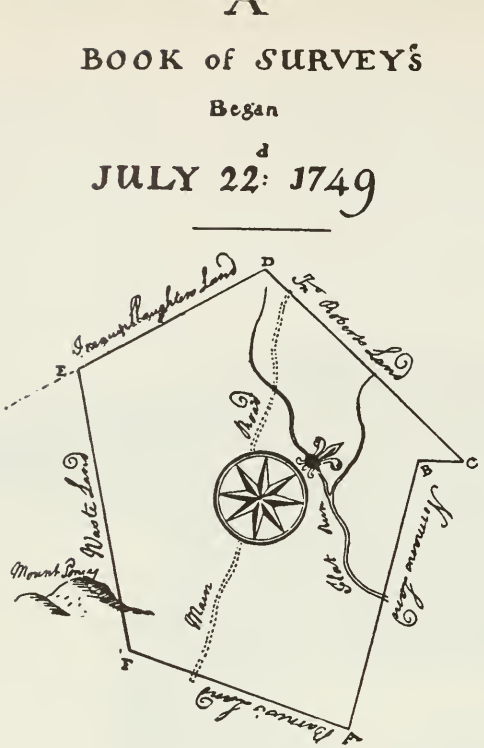


Facsimile of Title - Page of Survey Notebook in Washington's Handwriting

SURVEYING and AMERICAN HISTORY

by
Thomas B. Berns

In the study of the history of the United States many observations of a seemingly insignificant nature come to light concerning the men who formed the destiny of America. These observations might seem insignificant in themselves, but when viewed from a collective point of view, an interesting coincidence of meaning can be drawn.

One of these observations is the evidence of a definite connection between several American patriots, the destiny of America they helped form, and the art and science of land surveying. Surveying was the forerunner of today's engineering profession and as such was one of the first instances where mathematics and science were used to solve practical problems.

The surveyor in early America was a man of great importance for he held the key to wealth and power, control of land ownership. In many colonies (later states), it was necessary for a surveyor to lay out all claims before ownership could be certified. Thus, many influential people took this job as a public service and to forestall unscrupulous activity, as well as to increase their own holdings.

Due to the characteristics of life in early America almost all prominent citizens had contact with surveying and land management of some sort. However, the connection is most evident in the lives of George Washington, Thomas Jefferson, and Abraham Lincoln, who had much more than a passing interest and acquaintance with surveying. These three American presidents actually served as land surveyors and there is evidence that their experience with surveying affected their lives and the future of the country which they helped build.

George Washington first became involved with surveying of a responsible nature at 16 years of age, when he crossed the Blue Ridge Mountains in the company of James Genn, a veteran surveyor, and George William Fairfax, agent for the proprietor of the lands. He recorded this venture in his diary, *Journal of My Journey Over the Mountains, While Surveying for Lord Fairfax, Baron of Cameron, in the Northern Neck of Virginia, Beyond the Blue Ridge, in 1747-8.*

George Washington was examined by William and Mary College in 1749, and at the age of 17 was commissioned surveyor for newly formed Culpeper County, Virginia. Qualifying at a time when settlement was extending rapidly up the Shenandoah Valley, he was in a position both to accumulate fees in cash for laying out the claims of others and to patent land of his own amounting to approximately 1,000 acres by 1750. Once commissioned, Washington was authorized to survey in any county in Virginia, and he was profitably occupied until the fall of 1751 when he sailed for the Barbados to attend to family matters. He later resumed surveying and continued to practice surveying throughout his life except when public service prevented.

The heritage of surveying was well established in Thomas Jefferson's family, since his father, Peter, had been Deputy Surveyor of Albemarle County, Virginia under Joshua Fry and his great grandfather had likewise been a surveyor. Thus, it is not surprising to find that the faculty minutes of William and Mary of October 14, 1773, state that the "President and Masters unanimously agreed that Mr. Thomas Jefferson be appointed surveyor of Albemarle and that he be allowed to have a Deputy". Indications are that he spent little time in this occupation, but did own a theodolite and surveyed his own lands and those of his close relatives.

Due to Jefferson's wide range of interests and his scientific mind, he probably was capable of surveying on a much higher plane of precision and competency than most practicing surveyors. It was his scientific approach to surveying combined with the practical knowledge gained from his family heritage and personal involvement that helped him formulate the basis of the land surveying system used in the United States to this day, as will be discussed later.

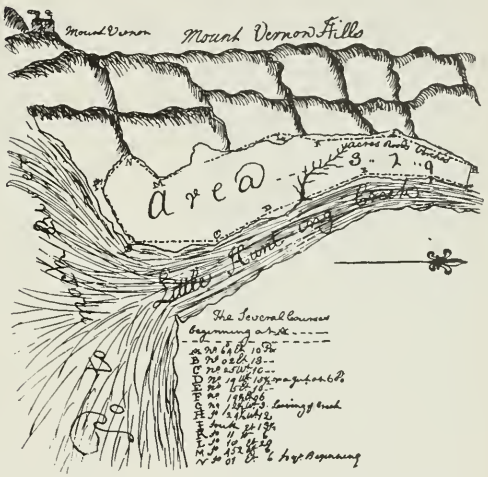
In June of 1775, George Washington was called upon by the Continental Congress to serve as General of the Continental Army. Washington's knowledge of terrain, gained through his years of practical schooling in surveying, mapping, and geographical exploration, gave him full appreciation of the need for cartographic information. He was immediately and painfully aware of the nearly total lack of this vital source of intelligence and repeatedly implored the Congress for assistance in finding qualified personnel because, "The want of accurate maps of the country which has hitherto been the Scene of War has been of great disadvantage to me . . . .".

In July, 1777, the Continental Congress finally empowered General Washington to employ geographers and surveyors. There is evidence that the maps Washington received from his surveyor-scouts aided the American cause greatly in the latter part of the Revolutionary War.

As Governor of Virginia during the latter years of the Revolutionary War, Thomas Jefferson received and interpreted much intelligence about the British, French, and American forces, and there is no doubt his surveying background aided him in converting this intelligence to maps and military information.

In 1784, under the Articles of Confederation, a committee was formed with Thomas Jefferson as chairman to devise a means of disposing of the western lands. The basic system of rectangular land surveying was adopted as proposed by Jefferson's committee and is the basis of the land surveying system used in the United States today.

In 1803, on the eve of the Louisiana Purchase, Jefferson, then President, set in motion a succession of



Facsimile of Map of One of Washington's Earliest Surveys; Part of the Mt. Vernon Estate on the Potomac River

geographical explorations and surveys that were largely responsible for securing for the United States the country to the Pacific Coast. Of these expeditions, Zebulon Pike's expeditions from St. Louis up the Mississippi and from St. Louis toward Santa Fe are prominent. However, the most significant was the Lewis and Clark expedition to the Pacific Ocean which opened the Pacific Northwest to the United States. It was also during his years as President that Jefferson set up the United States Coast and Geodetic Survey Department, which was in charge of surveying and mapping all the public lands.

Thus, it was the leadership of a man knowledgeable in the meaning and value of maps and surveys that allowed the United States to validly claim the Oregon Territory and to set up an agency which helped open the frontier to settlers.

As the country passed from infancy into adolescence, the art and science of surveying likewise continued to grow and expand. The basic principles based upon trigonometry, algebra, and existing law did not change, but the equipment and methods increased in sophistication with the rest of the technical world.

In the latter part of 1833, a young man named Abraham Lincoln, having lost a bid for a seat in the Illinois Legislature, secured a job as Deputy County Surveyor in Sangamon County, Illinois. Lincoln, who was then 22, knew nothing about surveying, but borrowing books from the county surveyor and studying on his own, went to work as a surveyor. He became proficient as a surveyor as witnessed by the plats and field notes signed by him and continued in surveying until 1836. He left this field to continue studying law and to spend more time in politics since in 1834 he had been elected to the Illinois General Assembly.

It is interesting to note here that Lincoln had been defeated in his bid for a legislative seat in 1832 after returning from the Black Hawk War, but after engaging in surveying for approximately one year he was successful in his second try for a seat in the legislature. It would be naive to assume that his activity in surveying was the sole cause for this change in his electoral fortunes, but by having mastered the mathematics and requirements for such an important professional post, he no doubt raised his standing in the community no small amount. Another consideration which made surveying important to Lincoln at the time was that he was getting paid for both learning and building his political future while working as a surveyor.

In Lincoln's law career too, his surveying background paid him dividends. In 1859 he was called upon to render a decision on how the section was to be legally divided into quarters. It seems that the sole reason he was called upon in this case was his surveying experience. There is some evidence also that this background helped him obtain clients concerned with land transactions and mill rights.

Abraham Lincoln was elected President in 1860, and thus was the Commander-in-Chief of the Union Army during the Civil War. The knowledge of mathematics, map reading and reconnaissance gained while a surveyor no doubt aided him in functioning as Commander-in-Chief, and helped him formulate the plans for the Transcontinental Railroad and westward expansion undertaken while he was in office.

In addition to the obvious documented cases of how surveying influenced the making of America through the lives of these three men, there is one other consideration possibly more important than all the others, namely, that of character building.

Success in surveying necessitates close observation, intelligent investigation, judicious weighing of evidence, self-reliance, prompt decision, as well as the thorough understanding of mathematics and the law pertaining to surveying. It would be hard to imagine that the characters of Washington, Jefferson, and Lincoln were not at least partially shaped and molded by their early experiences in surveying. Each was affected by surveying in a different way, but the fact that it helped make them the leaders that made America great is undeniable.

In summary, it is interesting to note that if a choice had to be made as to who were the three men who had done the most to make America the great country it is today, it would be easy to choose George Washington, Thomas Jefferson and Abraham Lincoln, *all surveyors*, and thus, in a sense, engineers in America's youth.

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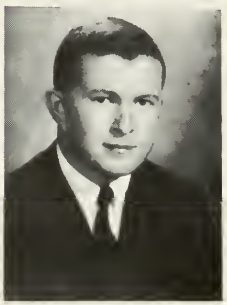

Thomas Berns is a senior from Plano, Illinois. He is studying Civil Engineering and was the recipient of the Rayner Award of the Civil Engineering Department for 1967.

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AFTER FOUR YEARS *or* THE WALKING DEAD

by Rex Hinkle

Last spring at a meeting of the Student-Faculty Liason Committee, Dean Wakeland suggested that TECHNOGRAPH was not perfect. After many talks and much study the staff reached the conclusion that in some cases TECHNOGRAPH was trying to do some things which were already being done better by others. This article suggests that the engineering societies and the engineering college take a look at themselves. Here, too, there seems to be much that is inferior duplication.

Rex Hinkle is a senior in electrical engineering and has been active in student engineering societies.

The best example of a very poor copy of what someone else is already doing is the usual society program. Why should anyone spend two hours listening to a lecture about some new engineering development or process when he can read about it in one of his favorite technical magazines in about twenty minutes? How in the world did it become established that in order for a meeting to be successful, it must have a lecturer?

Membership in a society should provide two services. One is providing a member with the society's national publication which informs him of recent technical developments. The other is the opportunity to meet students, faculty, and professional men in his field of study. The latter is what the local society can provide.

Societies could sponsor informal get-togethers of students and faculty at lunchtimes, between classes, and on weekends. Possibly cooperating instructors would agree to invite a few students into their homes two or three times a year (different students each time). This would be of special help to underclassmen.

Adoption of proposals similar to the above would make bi-weekly meetings unnecessary. Instead societies could spend their time sponsoring suppers, picnics, and other special events. Regular meetings should be for officers, committees, and other groups who have a special purpose for meeting. Meeting for the sake of meeting is a waste of time.

A couple of years ago at a meeting of society presidents one student leader asked for suggestions on how to attract students to his society. However, immediately following this request, he said in effect, "We do not want freshmen and sophomores in our society because we sponsor free plant visits, and we wouldn't have enough money if freshmen and sophomores went." This is an extreme example of one reason why the societies are "walking dead." The enthusiasm of some of the freshmen and sophomores working on Engineering Open House has demonstrated that underclassmen are often just waiting for an opportunity to do something in their college. In later years when the homework routine becomes established, it is much more difficult to get them involved, especially after they have been ignored for two years.

Societies, indeed, have little contact with underclassmen. Freshmen who indicate an interest in a society are often not contacted. Also the society meeting notices are posted only in the department buildings, and unfortunately many underclassmen rarely enter these buildings. Furthermore, the meeting topics are of little interest to anyone.

The locked doors of many societies' offices symbolize their attitude. These offices are reserved for those who have keys. Although an ego-inflater for a chosen few, needing a key makes it difficult for anyone else to stop in and see what is happening. Even upperclassmen sometimes have difficulty in finding out how to join. Instead of having to see an officer or attend a meeting to join, why not ask the secretary in each department office to take applications for membership? Furthermore, why not have a dozen or more student members act as "membership takers?" The names of these people could be posted and read in classes. Students could then ask these representatives questions about their respective societies and determine for themselves whether they are worth joining. To recruit underclassmen societies could set up tables at G. E. 100 lectures and also send out a newsletter with application blank enclosed to all students in the departments. Here again most departments would be glad to help.

A society does not have to be lack-luster and boring. This year IEEE and several other societies made sincere attempts to create interest in their programs. Yet they must keep in mind that they can not thrive by only reiterating ideas originally presented much more effectively by professional organizations.

The main purpose of the student societies is to help students understand what their fields involve. It seems

that practically every freshman and sophomore engineer has doubts about his chosen field. Unless he has worked with engineers during the summer, he has very little experience to help him decide how to prepare himself for his career. In fact he has few reasons to substantiate the branch of engineering he chose.

The college has stated that more entering engineering students actually graduate than entering students of other colleges. What the college does not state is that entering engineering students are to a large extent convinced that engineering is the profession for them. Few high school students consider engineering unless they are near the top of their class and are proficient in math and science. Those who are unsure of what they want to do in life or are pushed into college by their parents usually pick a college such as L. A. S. Instead of being content in leading the pack, the Engineering College should be concerned about why the catch-all commuter is not so far behind the express.

Dean Wakeland has stated that it is not the function of G.E. 100 to show students what certain fields of engineering involve. Furthermore, he says that this objective could never be attained without greatly expanding the course. But how can students learn about specific fields?

A senior in Aeronautical engineering has suggested that the college sponsor mandatory field trips to plants.

"Damn, did you ever try to think of a joke about engineers?"

Although expensive so is the plan to spend $10,000 to bring high school students to campus. It does little good to recruit freshmen just to have them transfer to a different college. Companies would be quite willing to back field trips, and it would not be difficult to find plants close by to visit. There are many in Danville and Decatur. Day long trips to Peoria and the Chicago areas would also be feasible.

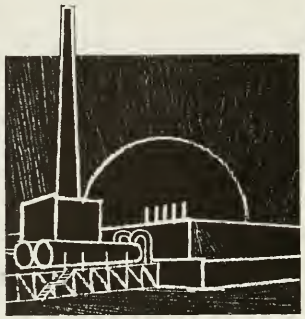
These trips should be well planned by educators who have had experience in industry. They should not be equipment tours but glimpses of people on the job. Students should be able to ask questions and should be informed of the training required and the future of the different jobs. In order to help improve future tours, students should be quizzed about what they have learned from each tour.

Each engineering student should be required to take perhaps three trips and should receive credit. The trips could be combined with three or four class sessions to give one or two hours credit. During the classes speakers from industry and from the college could describe their respective offerings. Most of these classroom sessions should be broken up by departments. Perhaps a few, though, could discuss the problems of society and the role the engineer can play.

The college should have someone with experience in industry to coordinate the program and to set up the tours. This program should be given top priority and should be staffed accordingly. It should be constantly re-evaluated and should not rely only on the tours to do the job. Other ideas should be tried if and when suggested. Some classes in the College of Agriculture take similar trips already. If the Engineering College has doubts about the feasibility of such an idea, it might be able to receive some help from its south campus neighbor.

To obtain the credit hours to make room for such a program, most departments could drop or combine some lab courses. In fact some departments already offer a combined lab program for honor students. For long-range plans several hours could be gained by eliminating the duplication of the basic physics courses and later courses in the departments. By allowing the corresponding departments to teach what is presently included in physics 106, 107, and 108, underclassmen would obtain both an introduction to engineering campus and a reduction in the number of hours required for graduation.

It is hoped that a trial program will be in effect by the fall of this year. Most of these proposals can be started "through channels" which seem to take several years. Work on the changes in the courses and hours can be started now though. The new Dean of Engineering would then have some basic proposals to consider, and he can determine the final course of the program.



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If, during that initial 12 months, you happen to make a significant contribution, you'll be rewarded accordingly. But the point is, we don't expect it. All we expect is that you keep an open ear and an open mind; that you work hard to develop as an individual. (We'll help you further your education—should you decide on advanced study.)

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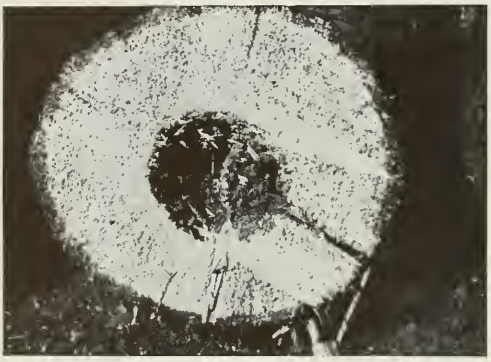
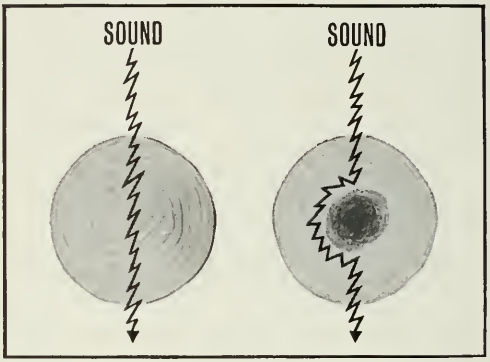
SPERRY RAND

Got an idea?

Detroit Edison's interested.



1. Edison engineer, Dick Popeck, wanted to find a more effective method of determining the amount of pole decay.



2. Dick's idea: Measure the time required for sound to travel through a pole. Sound takes longer to traverse a decayed pole.

3. Transistorized circuitry was designed. And a Sonic Pole Tester was built and tested.

4. Ed Hines, Director of Research, (left) discusses patent coverage with inventor Dick Popeck.

New ideas grow at Detroit Edison. The picture story here shows the progress of one, from its conception through its development, to finalization.

The development of the sonic pole testing device* has benefited the company and the young inventor both economically and professionally. The device helps Detroit Edison serve the electric industry's customers better and more economically.

Uses for the sonic pole tester range from the examination of wooden railroad bridges to the determination of the soundness of standing timber.

Detroit Edison's forward looking management . . . its engineering and research facilities . . . along with its liberal patent policy . . . make it an ideal place for the young man with ideas.

If you are interested in putting your ideas and energies to work—write to George Sold, The Detroit Edison Company, 2000 Second Avenue, Detroit, Michigan 48226, or visit the Edison representative when he interviews on campus. *U.S. Patent Applied for

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We make over 2,500 chemical products that various industries use to make better consumer products. There are 13,000 of us working together—1,500 in research alone. Whether you are interested in research, engineering, production or marketing we have work for you that will test your talents. You can progress in responsibility as fast as you demonstrate your capabilities. We are looking for people *now* who will be our management leaders in a few years. If you are ambitious, willing to work hard and are a graduate in an engineering discipline, we would like to talk with you—we could both benefit. Be sure to arrange an interview when our representative visits your campus.

Interview Date: March 14-15

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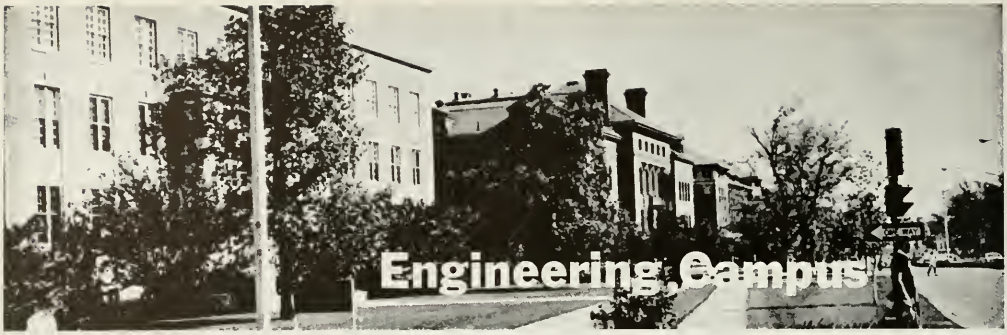

BARDEEN ASSUMES PRESIDENCY

Prof. John Bardeen of the University of Illinois assumed the presidency of the American Physical Society January 30 at the society's annual business meeting in Chicago. Prof. Bardeen has been a member of the physics and electrical engineering faculties since 1951, and he is also a member of the Center for Advanced Study.

In 1956 Prof. Bardeen shared the Nobel Prize as co-inventor of the transistor, and since he has received wide acclaim for the B-C-S theory explaining superconductivity. Among numerous other honors he received the National Medal of Science in 1965.

The January 29-February 1 meeting marked the first time that the American Physical Society and American Association of Physics Teachers met together. More than 800 technical papers reported advances in particle, atomic, nuclear, solid state, low temperature, and plasma physics.

Five members of the university's physics department delivered papers. Prof. David G. Ravenhall appeared before the nuclear division; Prof. David Pines, solid-state division; Prof. Hans Frauenfelder, nuclear division; Prof. Edwin L. Goldwasser, particles and fields division; and Prof. Jeremiah D. Sullivan, particles and fields division.

CRACKING CONCRETE HAS COME TO BE QUITE A PROBLEM

Engineers here at the University of Illinois are looking for a way to prevent winter damage to the concrete decks of multiple-span bridges. The damage is caused by water getting into minute cracks in the concrete and freezing.

This problem plagues highways from coast to coast. Last summer crack damage required extensive repairs on Chicago expressways and resulting traffic bottlenecks.

The latest idea to prevent these cracks from forming is to shake the wet concrete after it is poured. To investigate this idea the university has received a $100,000 research contract from the Federal Highway Research Board. Professor Hubert K. Hillsdorf of the department of civil engineering and Professor James L. Ott of the department of theoretical and applied mechanics are in charge of the project. The purpose of the research is to learn whether cracks can be prevented by using a slow setting concrete and going back after the whole floor is poured to agitate the concrete with pneumatic tools to compact the material into a crack-free surface. The project is scheduled to run 18-months and will include laboratory and field tests.

Four engineering graduate students and two undergraduates will work with Hillsdorf and Lott. The two undergraduates, both Sophomores, are Kenneth Malten of Des Plaines, Illinois and David Stumpf of Waterloo, Illinois.

"Well, I was pretty sure I had calculated the potential just right, because there was definitely a charge on the collector, but just when I began to increase the gain, the resistance went up enormously — that's when she hit me!"

OPEN HOUSE CENTRAL COMMITTEE ANNOUNCES PROJECT AWARDS

Engineering Open House with all its turmoil and confusion is March 8 and 9 this year.

The Open House Central Committee has developed new categories and criteria for judging of this year's exhibits. Cash awards, trophies, and certificates will be given to the following categories:

1. Two awards to the two society exhibits that best describe the academic life of an undergraduate engineer in a given field at the UI-$75 and $50.
2. Three awards to the exhibits that best explain the role of engineering in our society-$100, $50, and $25.
3. Three awards to the exhibits that best represent engineering research in a given area or field of engineering-$100, $50, and $25.
4. Three awards to the exhibits that best explain principles of engineering science-$100,$50, and $25.

The criteria for judging these exhibits will be:

Theme	20%
Aesthetic quality	10%
Visual presentation	25%
Oral presentation	30%
Explanation	
Discussion	
Overall opinion	15%

Those persons interested in competing for these awards should pick up forms in 106 Engineering Hall, fill them out completely, and return them by March 1 in order to be eligible. Any information concerning Open House can be obtained from any of the Central Committee members listed below.

Bob Giertz	General Chairman
Ray Klinger	Special Guests Coordinator
Bob Bower	Tours
John Funk	Awards and Exhibits
Liz Koranyi	High School Visitation
Llyn Granzow	
John Urbance	Information
Ellwyn Englof	Traffic
Bill Burrzinski	
Vivian Brosey	Publicity
Csaba Kohalmi	Space
John Hughes	Graphic Arts
George Elmos	Safety

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One of the outstanding properties of Malleable Iron Castings

Ductility is a property which provides Malleable iron with a vital safety margin for parts under stress.

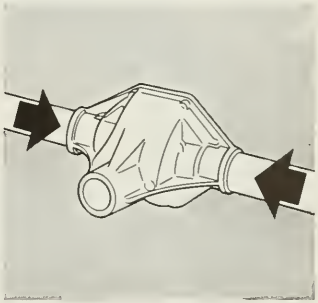
A special heat conversion process transforms the material from brittle "white iron" to a tough, ductile metal with 10-18% elongation in two inches for ferritic grades, 2-10% for pearlitic malleables. Ductility is important for two reasons:

1. It guards against sudden failure of a material. Under a static overload, a ductile part will deform gradually, giving visual evidence that failure is occuring. Impact will create sudden deformation, but unless the overload is far above anticipated levels, the part will stay in one piece.

The faith which engineers place in Malleable castings for shock applications is typified by the bridge rail posts pictured at the right. More than 30 states now specify Malleable for these posts because tests show the material can absorb greater impact than lightweight metals.

2. A ductile material can be formed in presses, and Malleable castings are commomly punched, roll threaded, joined to other parts, or otherwise formed to meet design requirements.

A well-known application is the Malleable differential housing on an automobile. On many cars steel tubes are rammed into each of the side ports of the Malleable differential housing to create the axle housing. The Malleable expands slightly to accept the tubes . . . then holds them rigidly for the life of the automobile. Despite the anticipated road jolts, the only joining operation is a small puddle weld to maintain alignment of the tubes.



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MALLEABLE FOUNDERS SOCIETY

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Isotropy is what the designer of this highly-stressed 335-pound tractor yoke had in mind when he specified *cast-steel.*

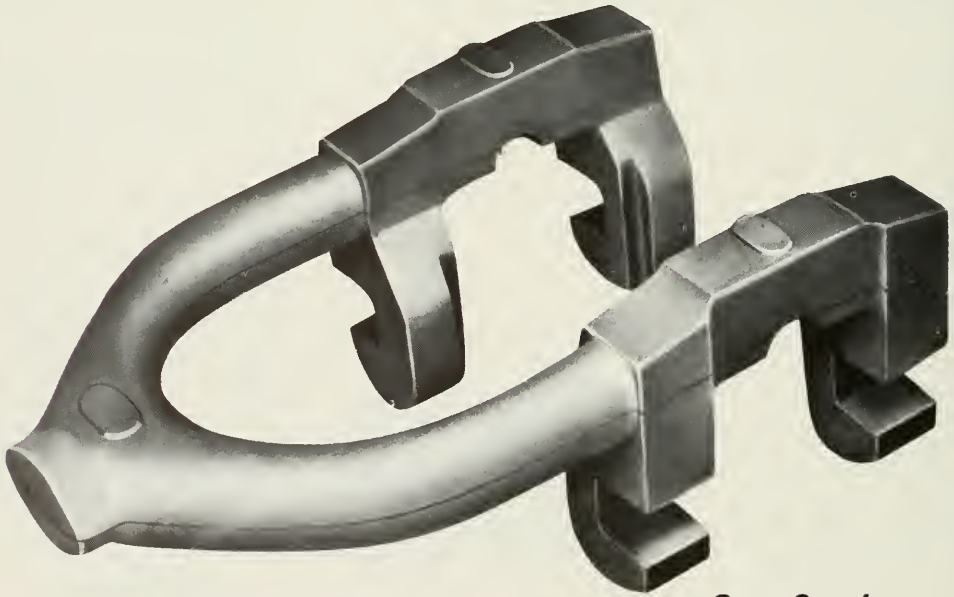
Not taken in by the shopworn "fiber" or "flow line" argument, he knew that road-building equipment is subjected to shock loads of high magnitude—in several different directions—so that he could not gamble with a construction where toughness, impact and fatigue properties are not uniform in all directions.

Cast-steel also allowed the designer of this tractor yoke plenty of engineering flexibility . . . He didn't have to worry about fitting together cumbersome wrought shapes, and he could put metal precisely where he wanted it for load-carrying ability, to avoid possible areas of stress concentration . . . And he could choose the steel composition which would give him optimum strength/cost ratio.

Want to know more about *cast-steel?* We're offering individual students free subscriptions to our publication "CASTEEL"... Clubs and other groups can obtain our sound film "Engineering Flexibility." Write Steel Founders' Society of America, Westview Towers, 21010 Center Ridge Road, Rocky River, Ohio 44116.

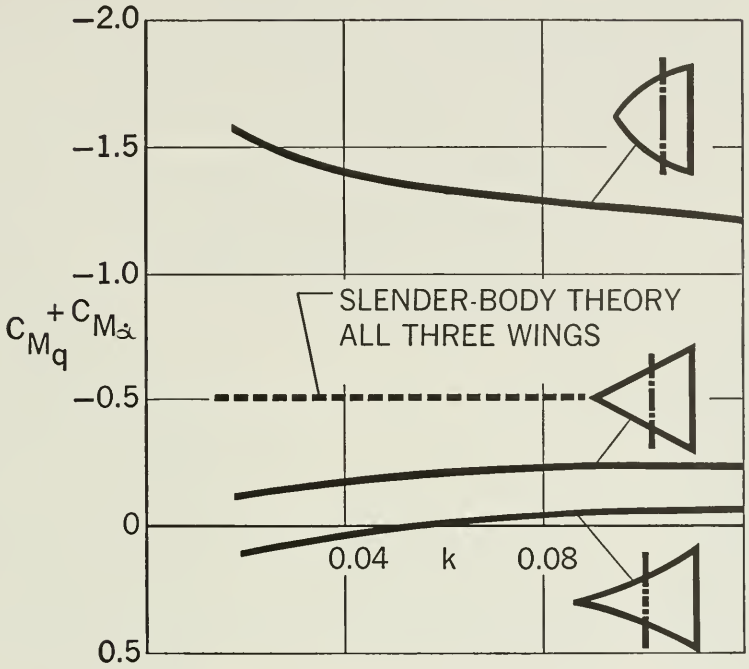
*Isotropic: Equal properties in all directions

STEEL FOUNDERS' SOCIETY OF AMERICA



Cast-Steel for Engineering Flexibility

Study transonic flow and make good grades.



Like Captain.

Take a look at any campus. Big. Small. Rural. Urban. You see the same thing: guys and gals. Same books. Same looks. Same hopes.

And you are there.

Some students really jam in every bit of opportunity they can grab hold of. Some just drift through.

Which are you?

Here's a good tip: If you join the Air Force ROTC program on your campus you'll know you're grabbing a big opportunity. Financial assistance is available. You'll graduate as an officer—a leader on the Aerospace Team. You have executive responsibility right where it's happening. Where the space-age breakthroughs are. You'll be able to specialize in the forefront of modern science and technology—anything from missile electronics to avionics. You can also be a pilot. You won't get lost in some obscure job with no future.

You'll also enjoy promotions and travel.

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And a commission.

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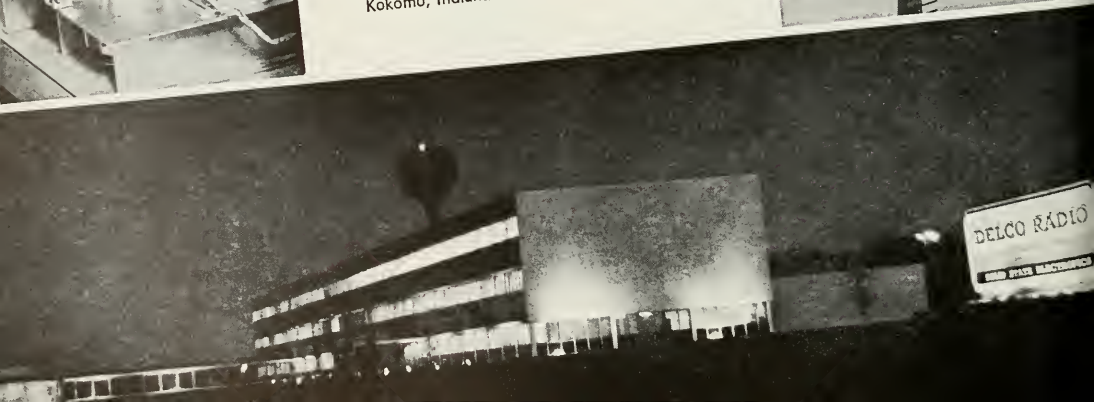

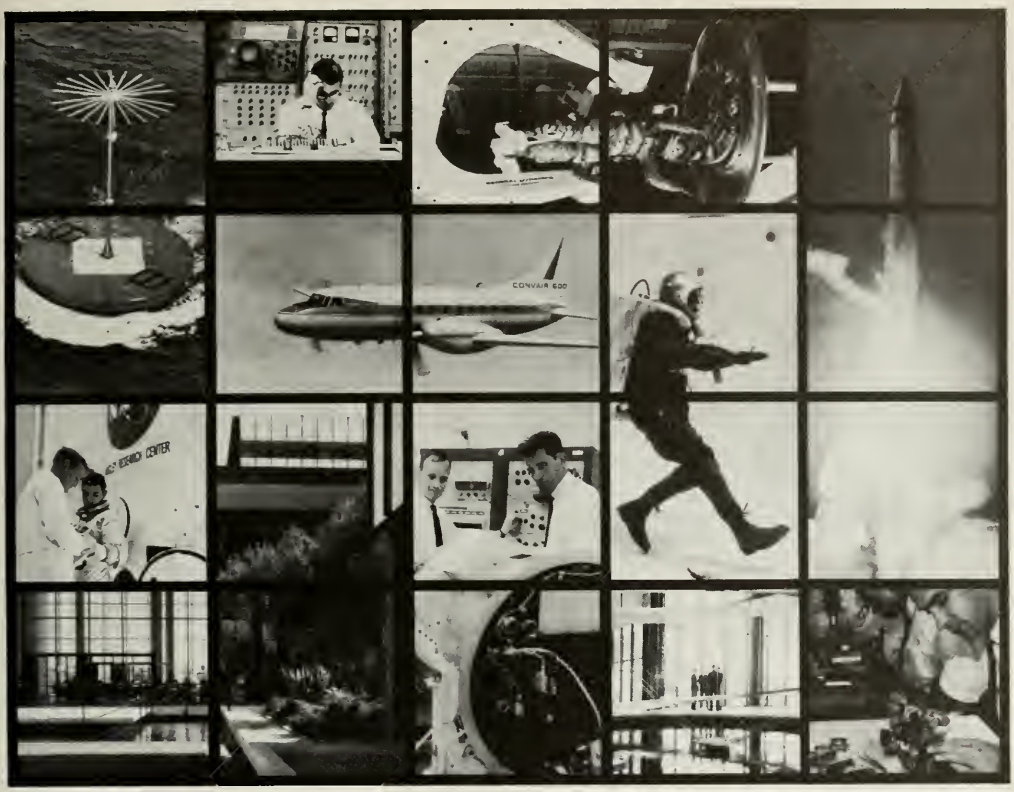

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A variety of outstanding career opportunities are yours at Convair in the following areas of concentration: aeronautical, electrical, electronic and mechanical engineering; engineering mechanics and engineering physics.

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Mr. J. J. Tannone, Supervisor, Professional Placement and Personnel, Convair Division of General Dynamics, 5625 Kearny Villa Road, San Diego, California 92112.

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To the Editor:

"Christianity vs Science" in Dec. 1967 magazine is excellent.

There are various sets of natural laws; for example, physical laws governing air and water are quite different. Air will not hold you up, yet you can float on water and be supported easily. A stick held in air will appear straight, yet when half immersed in water it will appear to have a break in it. You can walk easily and swiftly on dry ground, yet in shallow water you will tire quickly. These are natural laws which seem to contradict each other. We know they are all physical laws applied to different situations. And physical laws in space are still different, for in space heavy objects are weightless. These are not MIRACLES. They are physical laws in all cases but in different applications.

The miracles of healing, reading thoughts in another person's mind, prayer projected into reality, foretelling of specific events, angelic visitors, dreams revealing existing or future events in distant places, hearing voices that consoled or guided, are recorded in Biblical literature, and in the lives of Christian saints, and in the legends of all people everywhere. Such "miracles" constitute a folk-knowledge.

It is an awareness by certain persons of certain events. It is a sensitivity which transcends our normal understanding of time and space. It is as though we saw not the ship, but the wake in the water, not the airplane but the thin silver streak behind it. And under specific circumstances we can be aware of the event not *after* but *before* it happens. Thus space and time are transcended and a "miracle" occurs.

This awareness has been known to certain persons of greater sensitivity in every civilization, in every period of history. This is a folk-knowledge and a truth. It is nice to know that the scientists and theologians are finally catching up.

Theologians had an interesting attitude. They believed and preached about the "miracles" in the Bible, but they denied the existence of miracles today. If miracles were true then, they should occur today. If they do not exist today, they were lies in Bible times. The theologians never told us what year the miracles were turned off.

Florence D. Kuhn
4925 North Normandy Avenue
Chicago 60656 Illinois

To the Editor:

I must commend *Technograph* for pointing out in its December issue the existence of the three law courses offered by the General Engineering Department: 282, 290, 292. Having taken both GE 282 and GE 292, I certainly recommend that all engineering students give serious consideration to these two courses — not only for their value in future engineering pursuits, but also for the introduction to general legal affairs and the opportunity to meet members of the legal profession that they provide. I am certain that GE 290 deserves similar consideration.

The non-technical courses offered in the College of Engineering seem to suffer from a general lack of knowledge on the part of the engineering student body as to their content and value. *Technograph* might remedy this situation by presenting a series of articles describing these worthwhile non-technical courses, perhaps replacing the series being written by the magniloquent Mr. Moore.

John L. Welch
Senior
Electrical Engineering

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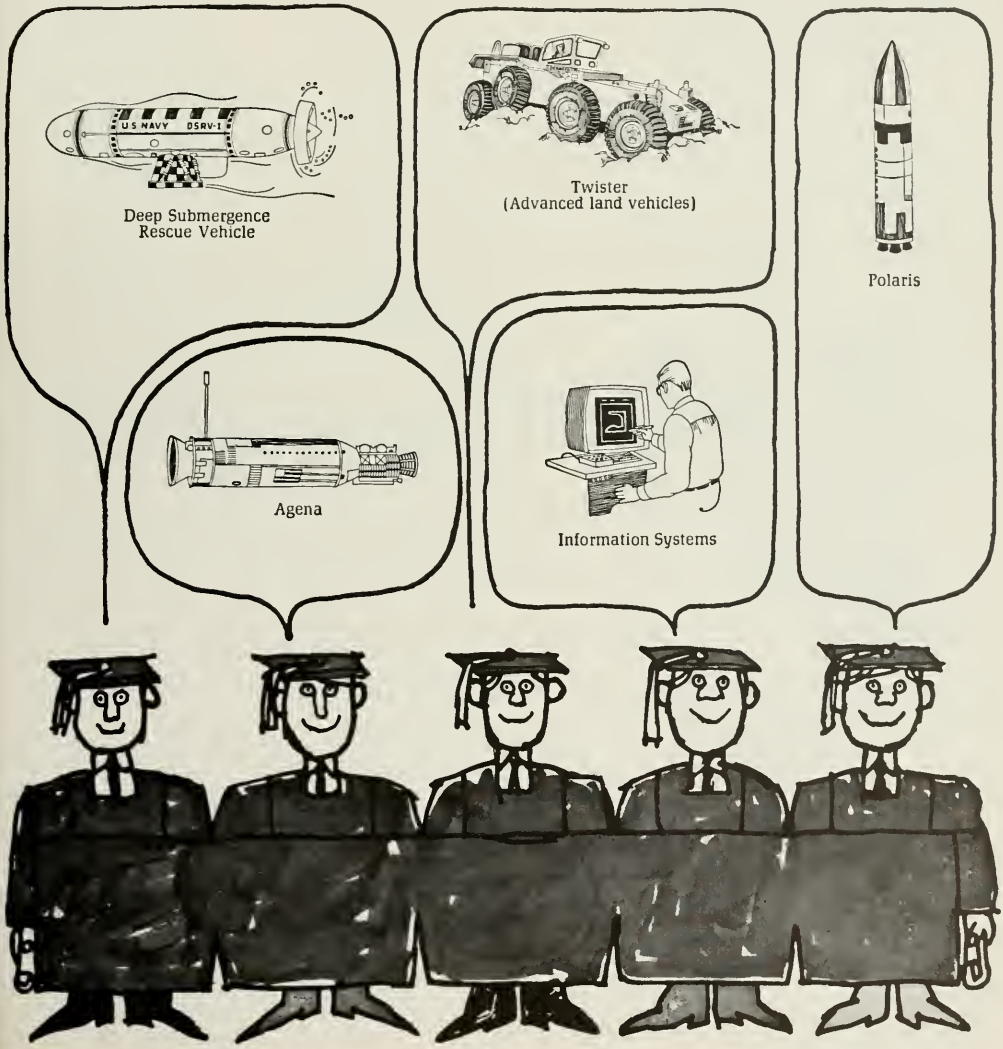

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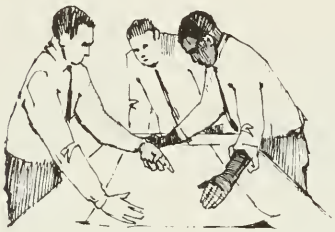

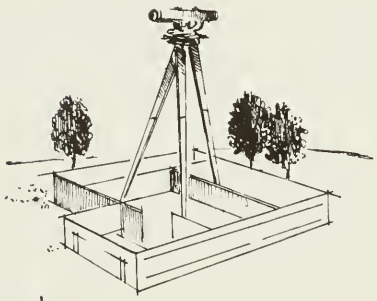

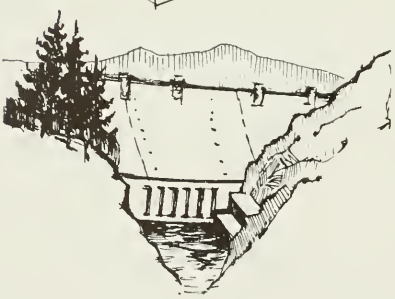

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■ An organization that recognizes each engineer as an individual, providing well-rounded career development programs with on-the-job training; courses at government expense in colleges, universities, and seminars as necessary to assure steady progression to top professional and managerial levels; encouragement and assistance in attaining professional registration and recognition; and an opportunity to win national and international awards.

■ An organization with offices and projects in nearly every one of the 50 States and in many foreign countries that encourages employees to further their development by accepting new and challenging assignments.

■ An organization which provides excellent rates of pay with liberal fringe benefits, including generous retirement annuity, complete health and life insurance coverage, paid vacation leave, military training leave with pay, generous sick leave; and special pay awards for outstanding performance and suggestions that improve operating efficiency.

If you're thinking this is all too good to be true, you're wrong! All of the above is available to you in a civilian engineer career with the U. S. Army Corps of Engineers. If you are interested, you can get further information from the Chief of Engineers, Department of the Army, Washington, D. C. 20315.

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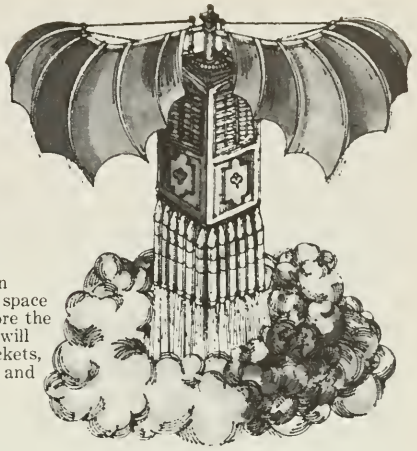
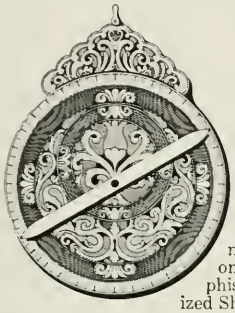
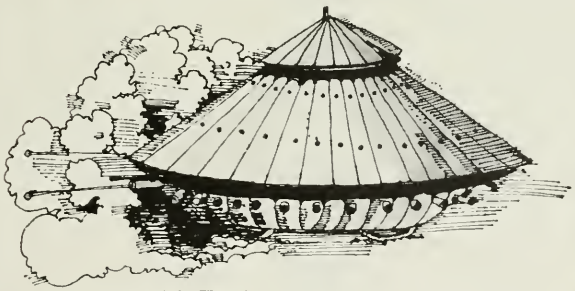


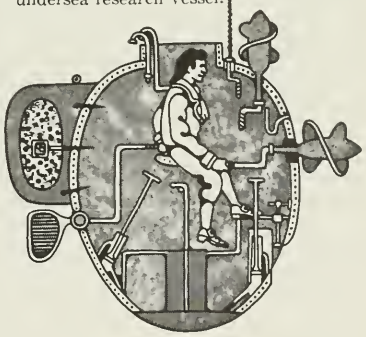


17th-Century Space Flight. Cyrano de Bergerac's science fiction fantasy about a box propelled into space by rockets came close to fact. Before the end of this decade, Apollo and LM will indeed be thrust to the moon by rockets, guided by AC Electronics guidance and navigation systems.

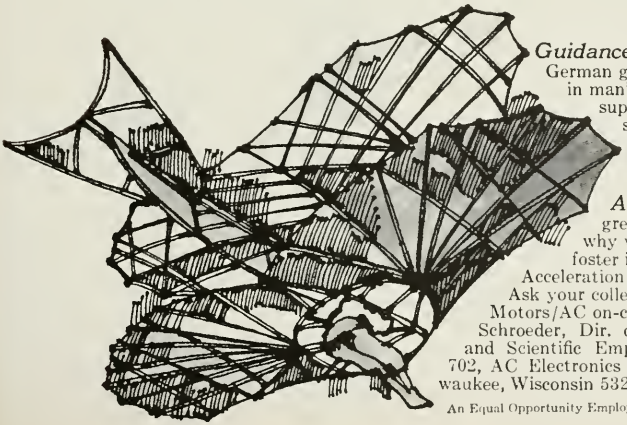
Navigation, Second-Century B.C. Hipparchus's second-century astrolabe was used for celestial navigation until the mid-18th century. Today, ships still depend on stars for guidance . . . through such sophisticated help as AC Electronics' computerized Ships' Self-Contained Navigation System.

Turtle vs. Eagle. In 1776, the American "Turtle" attacked the British flagship "Eagle" in the first wartime submarine action in history. Today, AC Electronics contributes to both the defensive and the scientific role of the submarine...with guidance components aboard our Polaris fleet, and with its own undersea research vessel.





Leonardo's Tank. Leonardo da Vinci was one of the first to envision the use of tanks in warfare. Contributing to the advanced state-of-the-art in tanks, today, is AC Electronics, with a computerized fire-control system for military land vehicles.



Guidance Gets a Lift. Otto Lilienthal, 19th-century German glider, proved that the future of flight lay in man's ability to guide the aircraft. Tomorrow's superjets will be guided inertially . . . by systems like AC Electronics' Carousel IV, chosen for the Boeing 747.

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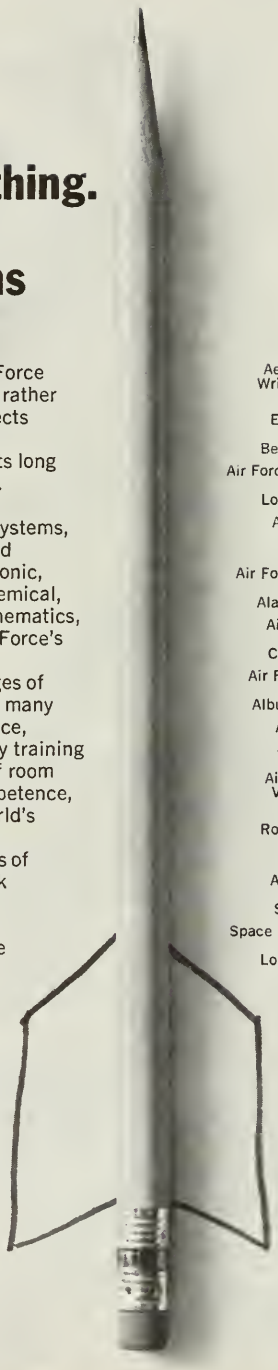

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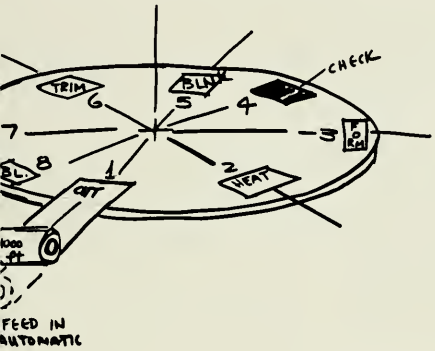

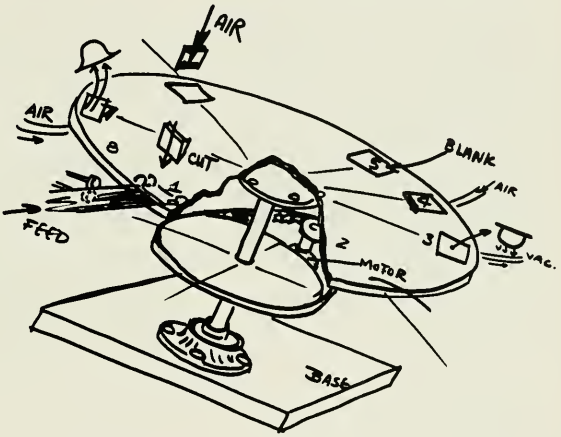

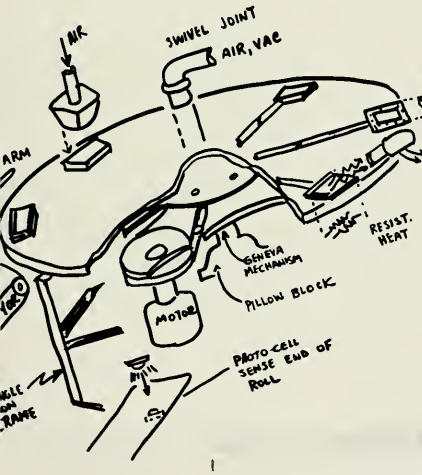

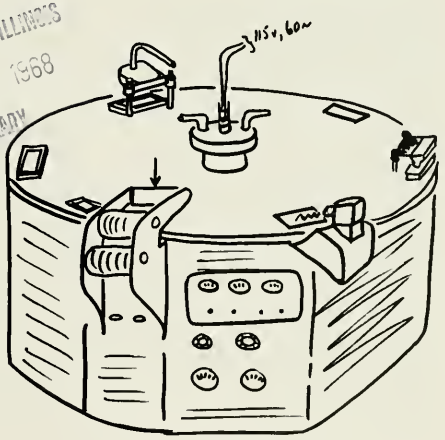

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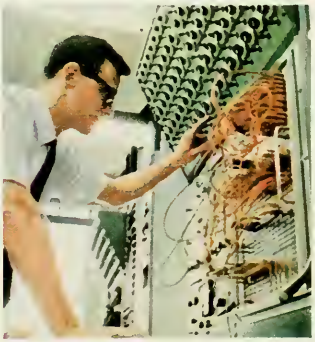

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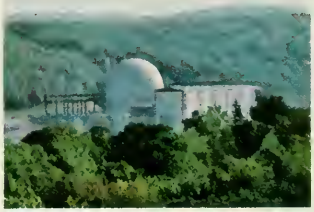

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"Take my own situation, for example. I act as a kind of entrepreneur for my department. I decide if we should bid on certain government contracts for my group and then develop the proposal strategy. Of course, upper management reviews my decisions, but to a great extent I run my own show.

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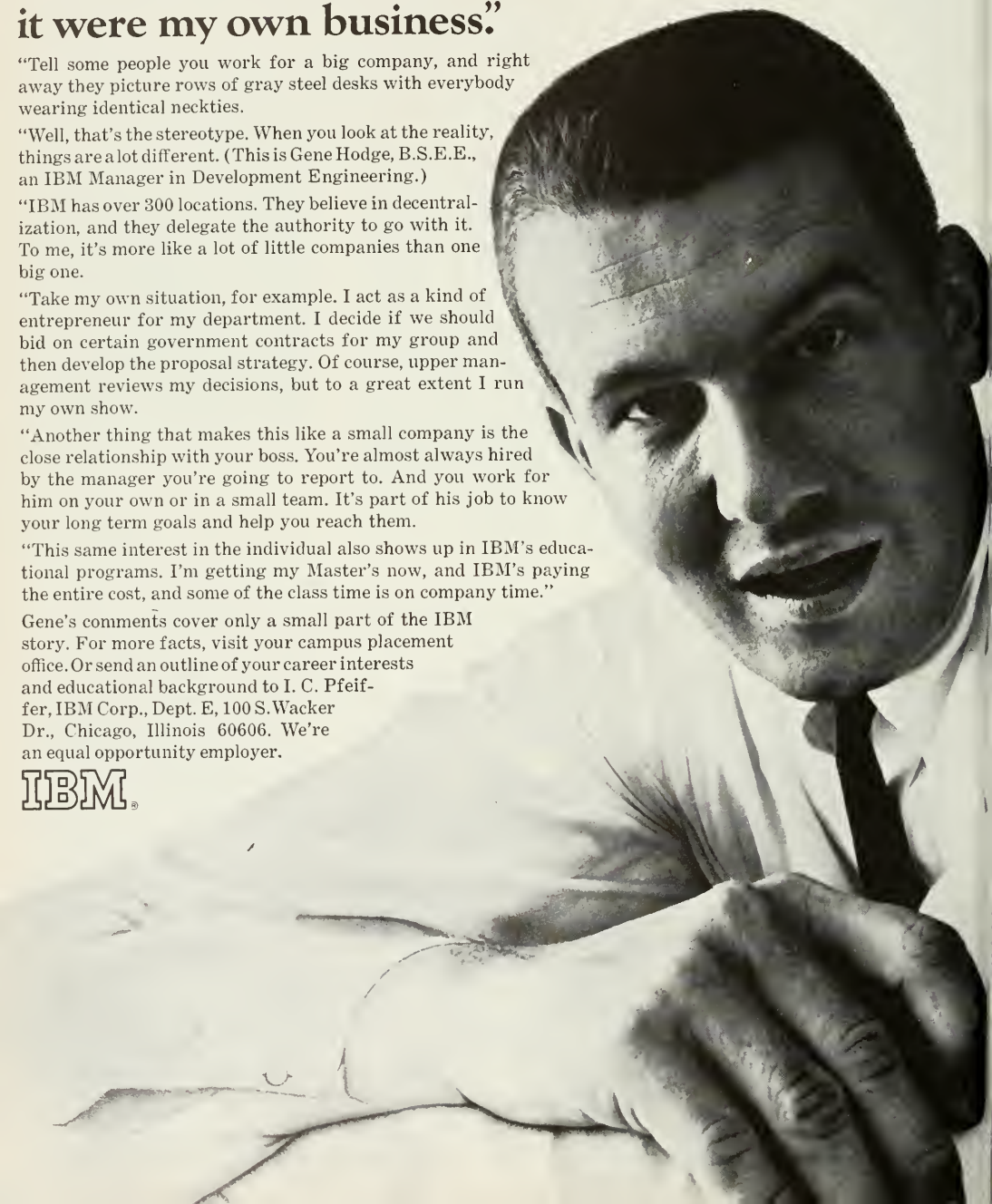

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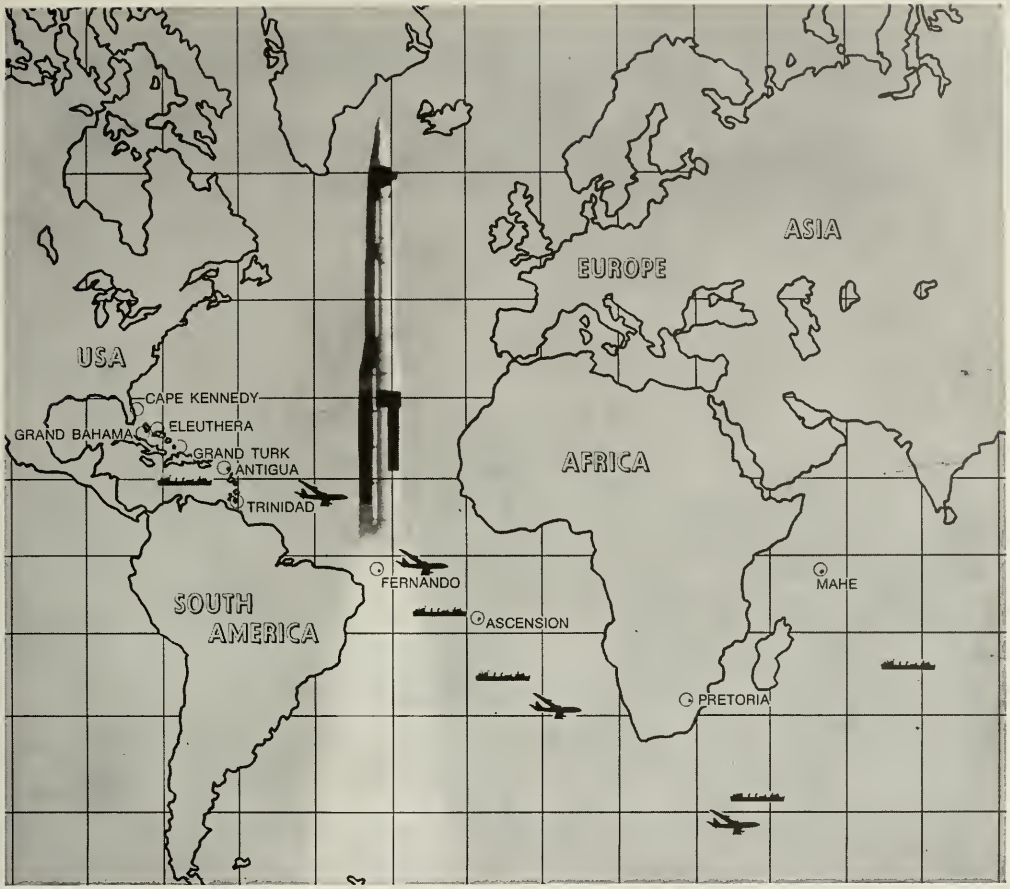
Speaking of art...

We'll be on campus March 21. If you miss our visit, write Mr. Harlow McGeath, Ryan Aeronautical Company, Lindbergh Field, San Diego, Calif. 92112



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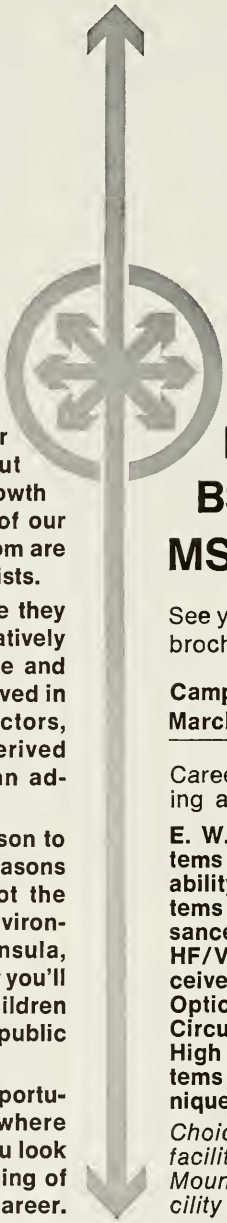
OUR GROWTH AND YOURS



You may not be particularly impressed by the fact that our staff has gone from less than 50 to over 3500 in the past fifteen years. But we'd like you to know about the growth behind that growth—the growth of our people, more than one-third of whom are professional engineers and scientists.

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Check us out; compare the opportunity here with that available anywhere else. If we look good to you and you look good to us, it could be the beginning of the most important phase of your career.

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March 21-22

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MARCH 1968
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COVER

This cover reproduces the actual sketches upon which George Morris based the design of his undergraduate research project. For more details about this interesting project, see page 14.

editorial

"... the great enemy of the truth is very often not the lie — deliberate, contrived, and dishonest — but the myth, persistent, persuasive, and unrealistic."

John F. Kennedy

The grades you get in College that you know about are supposed to indicate something about your intelligence and mental abilities. We have just learned that you are also given grades that you probably don't know about. They are supposed to indicate something about your personality and your abilities to get along with and communicate with others. These latter "grades" are solicited from your instructors and compiled by computer to be shown to recruiters who might hire you.

Students are rated as Outstanding (Top 3%), Excellent (Next 12%), Good (Next 40%), Fair (Next 35%), and Poor (Last 10%) in the following insightful categories: Personality, Judgment, Industry, Initiative, Leadership, Cooperation, Appearance, Oral Expression, and Written Expression.

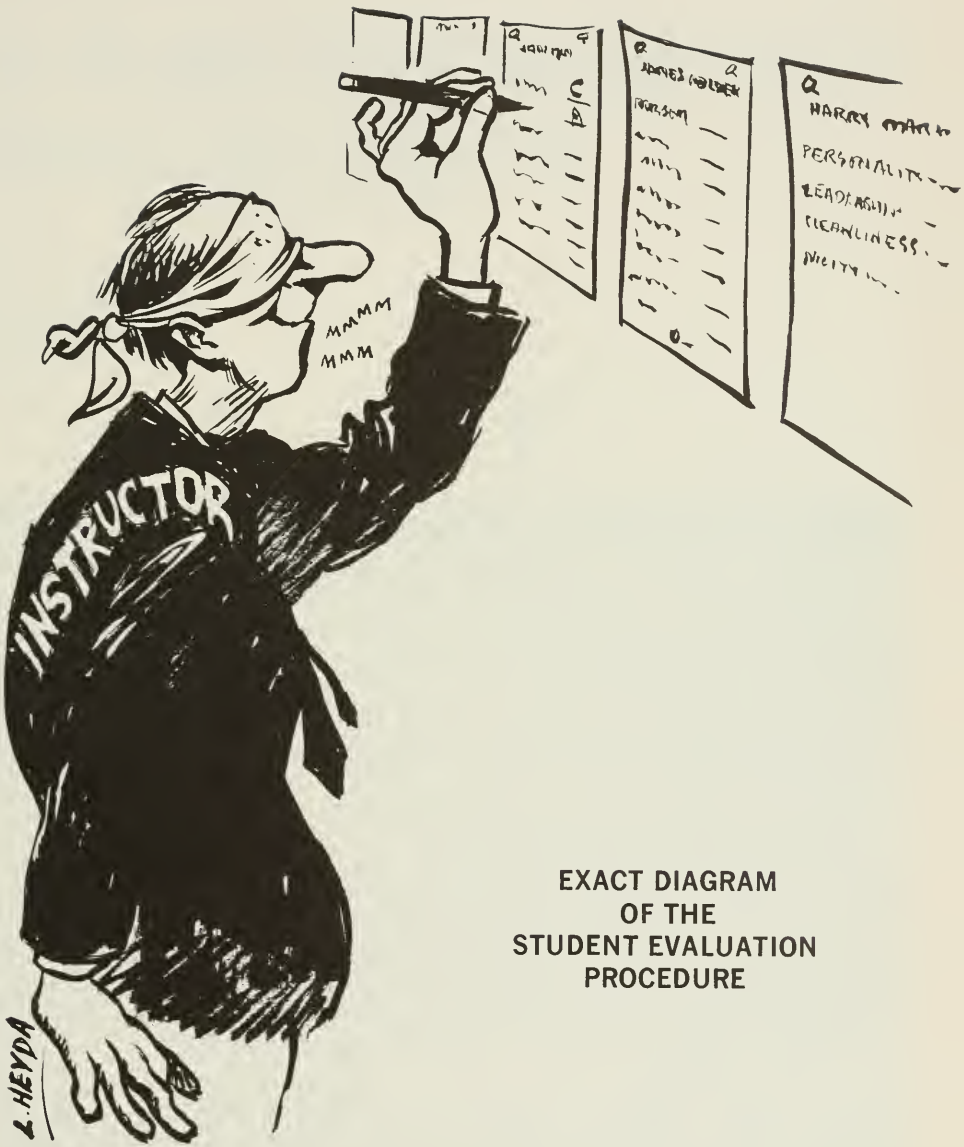
One new faculty member was appalled at being requested to evaluate his students in this manner. "Why should I be asked to judge a student on his verbal ability when I have him two hours a week in a laboratory? The categories are not only absurd, but it is grossly unfair to the student and an invasion of his privacy."

That the procedure is statistically invalid is unquestionable and incontrovertible. That it is a monumentally unreliable and deceptive measure is certain. By purporting to accurately measure immeasureable qualities, going even so far as to utilize data processing techniques, and by using a numerical procedure merely for the purpose of an administratively facilie "handy-dandy personality index", the system is doing a serious disservice to the College of Engineering by bringing into question the actual integrity and reputation of the institution. An institution of this stature cannot afford to pay such a price.

We are appalled and concerned as each of you should be. At best, any evaluation or grade is somewhat inequitable, but to quantify that which cannot be and should not be quantified under the guise of objectivity and fairness, particularly when a student's career is at stake, is just plain irresponsible.

To insure the continued integrity of the College of Engineering, and to protect its students from statistical folly, we of the TECHNOGRAPH staff urge and recommend that the practice be curtailed immediately. *

*If you are a graduating senior, the placement office will provide you with a copy of the data compiled on you.



EXACT DIAGRAM OF THE STUDENT EVALUATION PROCEDURE

School was out and no one had to call you . . . you were up at dawn. So many things to do—get out and work on the bike, find the rest of the gang and take off to explore your own private universe.

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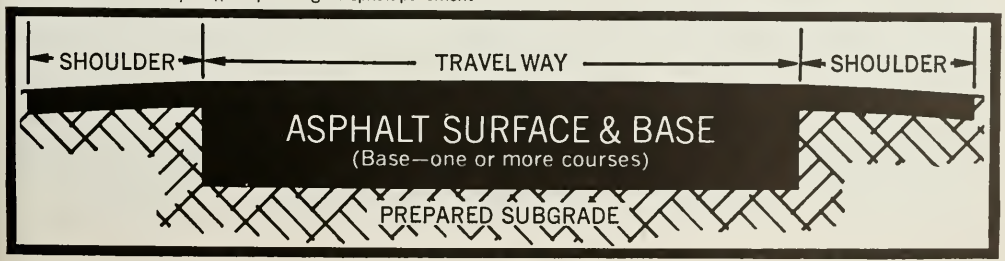

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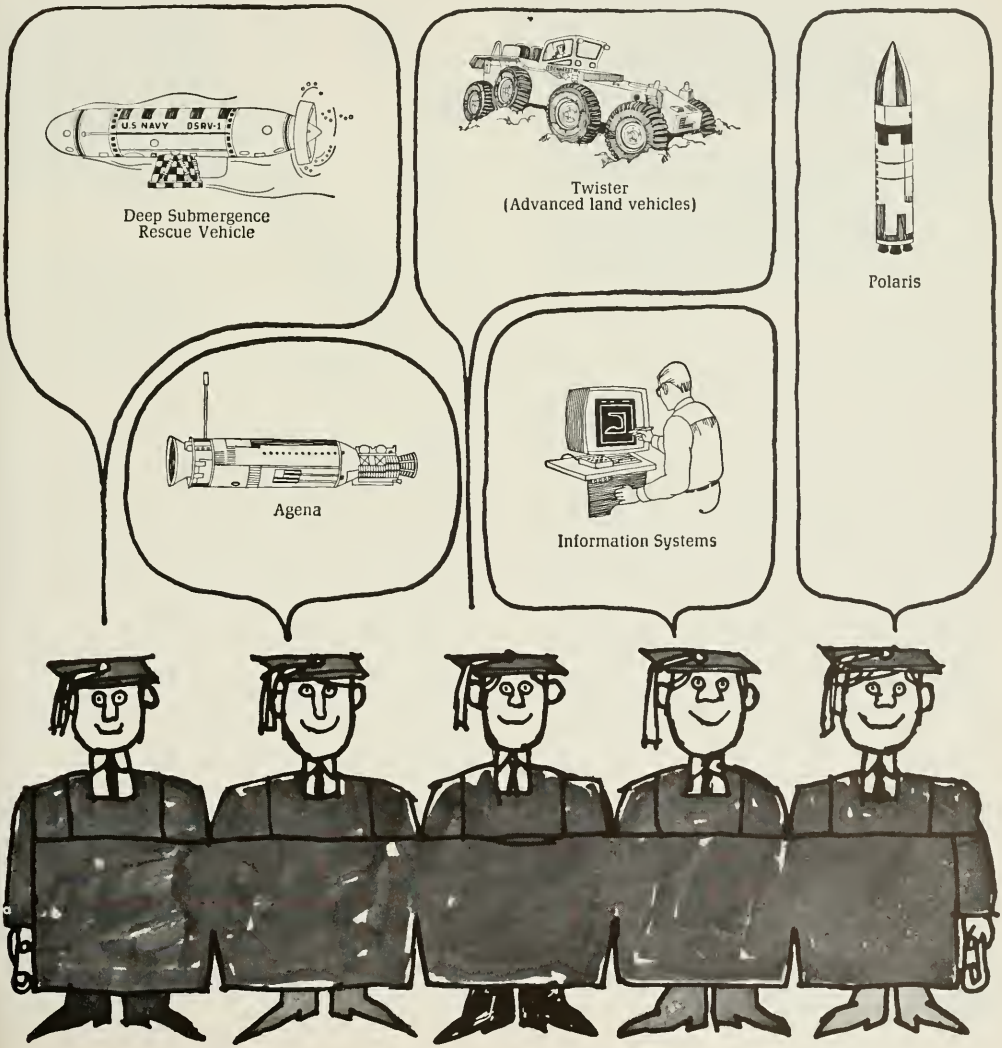
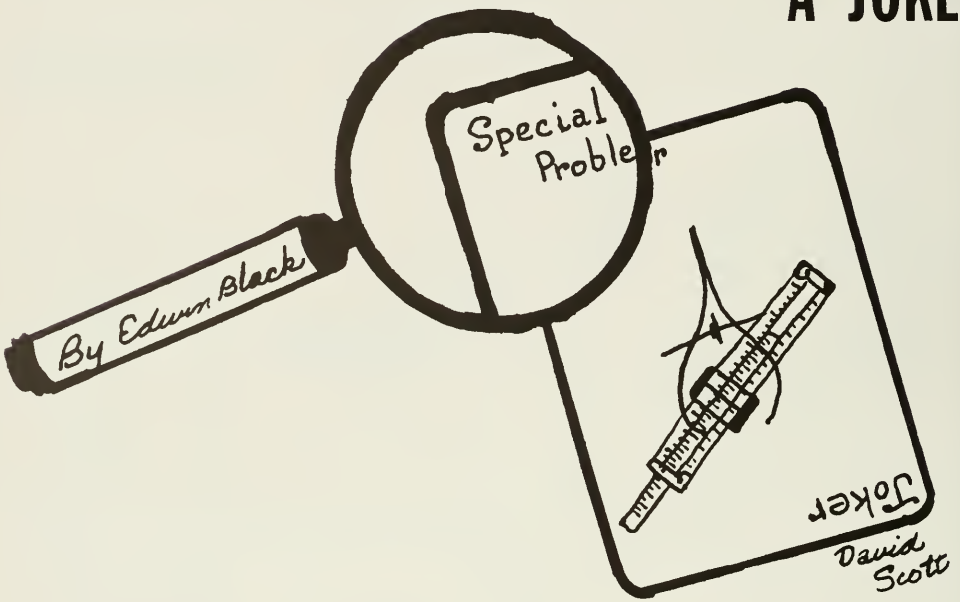


The Engineering Student's Square Deal – A JOKER



"The Special Problems course is our joker in a deck of cards," says Dean Wakeland. "Like a joker in a deck of cards, Special Problems courses cover many situations." They insure variety, provide for individual needs, promote experimentation, and appeal to unusual interests. It is the squarest deal the engineering student can be dealt.

Every department in the Engineering College maintains certain Special Problems courses designed to promote undergraduate research and give the willing student an opportunity to participate in actual laboratory research. The projects may deal with special interests of the student or may be assigned. Credit, ranging from one-half to four hours, is received for the work. At the disposal of the student is the expert guidance and aid of selected members of the faculty and millions of dollars of the most sophisticated lab equipment in the world. The student is faced with new problems whose solutions cannot usually be found in the tables. The student must make educated judgments and observe the results of his judgments. The result is an opportunity to test known principles or investigate new ideas relying on personal talent, technical know-how, and trained judgment. This invaluable and incomparable experience is taken advantage of by only a few students in each department. Yet participation is by no means limited to the honors' student or the upperclassman — the only prerequisite is interest and the only stipulation is initiative. Three examples of such initiative are the projects of Stephen Kaplan, Jerry Bonnett, and George Morris.

Edwin Black, freshman English major, is a professional free lance writer and reporter.

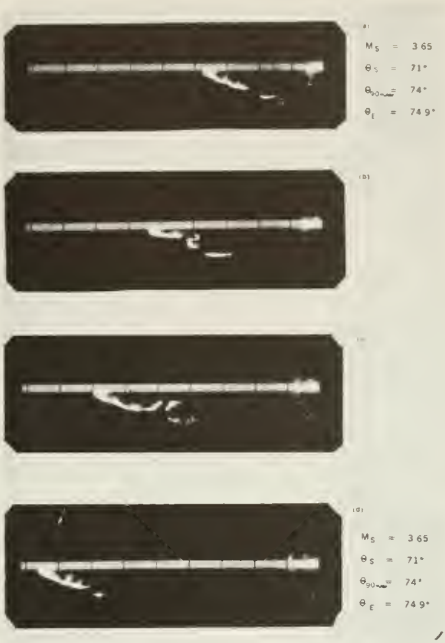
During the fall semester of 1967 a 23 year-old senior in Aeronautical Engineering named Stephen Kaplan applied to Dr. Charles Bond to work in the Magneto-hydrodynamics Laboratory. "Gas dynamics has always interested me," says Kaplan, "and particularly MHD,

which is a relatively new field and where practically all the lab work involves new concepts." At first Kaplan merely wanted to assist in the lab work and observe procedure in order to become more acquainted with the research he was so interested in. "When I began I had no idea it would turn into the full-scale research it did."

Stephen Kaplan, Aeronautical Engineering student from Highland Park, observed the stability of an electric arc in a new way.

Shortly after the term began Kaplan had an idea that he wanted to investigate. He wanted to observe the stability of an electric arc as it interacted with a conductive copper plate in a thermionic rail accelerator. The project was approved by Dr. Bond who availed all the facilities of the MHD Lab (run under the auspices of the Navy) to Kaplan for his study. "It sure exposed me to a lot of new situations. Often I couldn't explain a certain occurrence. There were times I could not coordinate the data or interpret my findings. There was plenty of frustration but in the end I always felt a big feeling of accomplishment. I knew I had made my own conclusions based on my own data. The great thing about one of these projects is that the work is yours — totally yours." Kaplan's experiment sparked so much interest that he was soon requested to write a report of his work which he is trying to publish. After presenting the report, *An Investigation of the Stability of the Electric Arc Interaction with a Solid Body in Thermionic Rail Accelerator*, there was even some controversy over the conclusions. "I put in about eight hours of lab work per week on the average and received two hours of credit; but more important, I received excellent preparation for on-the-job lab research, and this will be impressive when I go for my interviews."

Kaplan's findings in the experiment was that the electric arc remained stable despite an interaction with a solid body. He is anxious for a job in propulsion system design. When he applies he has the strong support of his initiative behind him, a recommendation the employer values. This is something George Morris knows.



These unique pictures taken with a special Fasta Camera reveal the stability of the electric arc that interacts with a solid body. In this thermoonic rail accelerator the Mach speed (M) and angles are shown to remain constant before and after the interaction.

A part-time Mechanical Engineering student, George Morris applied to Dr. Carl Larson for entrance to ME 293, a Special Problems course at the undergraduate level for Mechanical Engineers. By doing this, he was able to satisfy the technical elective requirement for graduation. "I was intrigued by the Design Problem Contest then offered by the American Society of Mechanical Engineers. I wanted very much to tackle it. They wanted a design for an eight-station rotary vacuum-forming device, and I wanted to see if I had the ability to give them something impressive."

During the spring semester of 1966 the part-time senior devoted twenty-five hours a week of spare time at home to the project. He received three credit hours from the college. "As soon as Dr. Larson gave me the go-ahead and approved my project I sat down to work. I held down a full-time job plus my nine academic hours while doing the project. At first, just everything went wrong. "Primarily, the difficulty was in planning an eight-station vacuum-former. Morris chose polypropalene, among the hardest plastics and the most difficult to work with, for his machine.

The design had the apparatus automatically feed itself 1000 ft. rolls of the polypropalene plastic, cut them to length, heat (temperature control by radiation thermometer), form, trim, and eject a molded piece of plastic which could be conveyed to a station for a leakage-test. The machine used both "male" and "female" molding procedures (a concave mold is a "female" mold and a convex mold is "male") in a vacuum. Action was regulated by a Geneva mechanism, which controlled indexing.

This original rotary design was submitted to the ASME contest. It was adjudged the second best design in the nation, for which Morris received $250 prize money. University honors were numerous since Morris had been only the second undergraduate in the University's history to receive the award.

George says, "This Special Problems course is just fantastic. It elevates you from the everyday routine to go into a project using your own arms and legs to swim. In my case it satisfied my requirement, helped me win a great prize, and really gave me an opportunity to exercise a willingness to design something on that scale. There's a great sense of achievement in this work, and something to look back upon."

Professor Lee Sentman of the Engineering College had this to say: "The Special Problems course presents a unique dilemma to the student. His answers depend entirely on the material he has gathered. He must function as he would were this on-the-job research; considerations include time, materials, costs, and procedural factors, as they would in any professional research." Jerry Bonnett's entire experiment was concerned with time, materials, procedural, and cost factors.

Part-time student George Morris from Peoria is employed by the university as a non-academic employee while pursuing his studies as an undergraduate in Mechanical Engineering.

Jerry Bonnett's project was begun in the summer of 1967 when he collected all his data. The study is still in progress as the final analysis and write-up are still under evaluation by the tester. The senior in Agricultural Engineering embarked upon his project to satisfy his requirement for an undergraduate research paper.

"I live in Havana, Illinois, a city in Mason County. I've been interested in irrigation systems for a long while now because my father deals with their sale." Bonnett had noticed that sandy-textured soil held very little rainfall. Moreover, during the growing season when rain is needed the most, it comes in the smallest amounts of the entire year. Periods of drought in Mason County have necessitated supplementary irrigation for maximum crop yields.

"Since several irrigation systems were being used in my county, I had an idea for a project to conduct a comparative study of the different systems." In the spring semester of 1967 Bonnett applied for a fellowship through the Special Problems course. He was granted $60 per week to carry on a time and motion study of six different irrigation systems in Mason County. All the equipment he could not get was supplied through the Agricultural Engineering Department.

Mason County resident Jerry Bonnett made a study of his counties irrigation methods.

"I was pretty sure my study was unique since most irrigation studies are performed in arid areas and rarely are they done in humid areas. I considered area capacity (acres/hour), labor requirements, water distribution uniformity, and a number of other data. Although all the data has been compiled the results are not completed yet. When they are completed, I will receive four hours in credit for the forty hours per week I offered to my work. I admit there was a lot of hard work, but every time you did something it made you feel like you did something all on your own and it make your work seem significant..."

The work is significant. Bonnett's project is one of many that are conducted through the Special Problems courses. What are they good for? They are good for the engineering student that needs a joker to help him in this game. They can develop that special penchant for propulsion studies, that fascination for transistors, that need for extra knowledge in computer design, that release from five-days-a-week-class, eight-hours-a-day-textbook. The Engineer's joker enables him to achieve something more than classroom hours and study time. It puts him into the heart of the action for which he must wait so long. The Engineer has this joker at his disposal; he may as well play his hand and win for a change.

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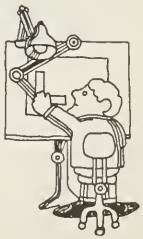


THE ALLERTON HONORS CONFERENCE WILL SEEK TO ILLUMINATE AN IMMINENT CHALLENGE FOR THE YOUNG ENGINEER:

"ENGINEERING and

by Donald A. Hanson

Donald Hanson (senior, EE), William Veatch (senior, Physics) and Stuart Wilkening (junior, GE), as student members of the college honors council, are assisting Professor J. O. Kopplin in planning the Allerton Honors Conference to be held April 5th and 6th.

The engineer has learned to manipulate his physical environment with the aid of his knowledge of how nature behaves, that is, with the aid of his ability to *represent* physical processes quantitatively. He can describe the current flow in a minute integrated circuit, and he can calculate the power efficiency of a mighty diesel engine.

Unfortunately, the engineer has not had a corresponding success in molding his social environment. This failure is partly due to a lack of knowledge of human affairs and partly due to a lack of agreement about human goals. In other words, from the engineer's point of view, he has traditionally not been able to *represent* the nature and goals of human affairs quantitatively. Hence, human affairs have traditionally never been the subject of the engineer's endeavors.

This lack of social responsiveness is changing. The expedience of the politician, the abstraction of the intellectual, the sensitivity of the artist, the service of the do-gooder have all failed to alleviate the impending crises in human affairs. In the face of desperation, the engineer must contribute his abilities in developing a new, broad, far-sighted, systems approach of dealing with certain human problems.

The engineering profession has been quite influential in developing the systems approach applied to complex military and space systems. In these applications systems analysis, systems planning and systems coordination are crucial, since the contributions of many specialized people and parts must add up to the desirable result. Technically, the systems approach means understanding the overall system, *representing* the system using mathematical models, defining the goals of the

The Allerton House is part of a 1500 acre estate donated to the University of Illinois by Robert Allerton in 1946.

URBAN DEVELOPMENT

system in terms of mathematical criteria to be optimized, studying the response of the system using computer simulation, and finally, manipulating the actual system in a desirable fashion using modern technology... Obviously, this approach is essential in controlling the Apollo system. But now consider a transportation system or an architectual development system or other urban systems with all their complex interrelationships. To what extent can these systems be represented and regulated using engineering concepts?

This is the question to which Professor von Foerster will address himself in the first session of the annual Allerton honors conference, which this year will deal with the topic of "Engineering and Urban Development." Von Foerster's talk is entitled "Potentials and Limits of Engineering Concepts in Problems of Human Affairs." He is a professor of Electrical Engineering and Biophysics and head of the Biological Computer Laboratory at the University of Illinois. However, his contributions extend far beyond narrow technical disciplines. His unique Austrian style, his wide experience, and his deep insight have made him a well-known figure on the U of I campus. For the second session, von Foerster promises to bring one of his expert friends from Washington, D. C., to deal with the underlying causes of urban problems.

The Allerton conference will be held this year at the beginning of Easter vacation, April 5 and 6. A bus will leave campus at about 2:10 P.M. Friday to go to Allerton Park. After the registration and welcome address by Dean Everitt, Professor von Foerster will begin at 4:00. The second session will follow dinner. The late evening is free for discussion, exploring, or sleeping. On Saturday there will be two sessions in the morning and two in the afternoon. The conference will conclude at 6:00 after dinner, at which time a bus will return to campus. A Humble Oil Company grant of several thousand dollars will cover all the expenses of the conference.

Saturday morning Professor John G. Duba will discuss "The Effectiveness of Government in Shaping the Urban Environment." Professor Duba is particularly qualified to discuss this topic, since for many years he led a half dozen government committees dealing with the urban environment of Chicago. He is now head of the Civil Engineering Department, professor of environmental engineering, and director of the center for urban environmental studies at Polytechnic Institute of Brooklyn.

Following these general remarks on concepts, causes, and effectiveness in dealing with urban problems, will be presentations analyzing the specific urban systems of transportation, pollution, structures, and growth. Study-

"Girl with a Scarf" is an appealing speciment of contemporary art displayed in Mr. Allerton's Brick Garden.

Displayed at Krannert Art Museum's "Century for Design" exhibit is Temenopolis II, which will be located west of Chicago, just south of Route 66, near Argonne Laboratories. The buildings will be liberated from the servient relationship to the roadway. Roofed-over and climate-controlled environment are being considered. Places of work, shopping, education, and recreation may very often be within walking distance from the private dwellings. Temenopolis II will include a large scale university center.

ing other urban systems of great importance such as law enforcement, public care, and education will be left to the student as an exercise (not really).

"Metropolitan Transportation Systems Planning" will be critically evaluated by Professor Britton W. Harris, who heads the environmental studies laboratory of the University of Pennsylvania. Transportation systems are a prime example of a problem intimately woven into human affairs and defintely requiring a systems approach solution. The goals of a transportation system not only include functional efficiency but also both the provision to meet the needs for the future and the welfare of the individuals and social groups who feel its impact.

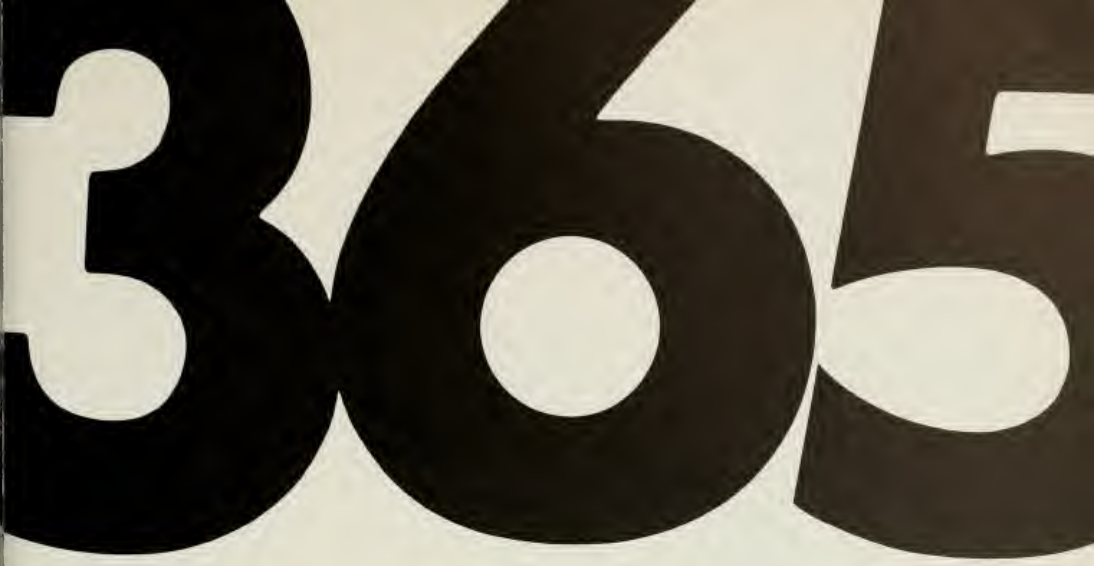
Next, Mr. Vinton W. Bacon will speak about the problems and challenges associated with urban air and water pollution. Mr. Bacon is General Superintendent, Metropolitan Sanitary district of Chicago. His vast experience allows him to speak as a prophet predicting the consequences of this grave problem.

The last speaker will be Professor Alexander Tzonis of the department of architecture at Harvard. He will discuss urban structures and growth and then react to the conference as a whole with comments and conclusions.

In addition to the official speakers, several special guests in the field of urban development will be present, along with many U of I professors. The Allerton conference offers an opportunity for the junior and senior honors students in engineering to meet with their faculty, to have an enjoyable experience with their fellow students in an ideal atmosphere, and to discuss a timely topic with experts in the field.

As is portrayed at the Krannert Art Museum exhibit on the urban crisis, this is the "Century for Design." The purpose of the exhibit is "to communicate the urgency and essence of environmental problems and to demonstrate how enlightened design may contribute to bring about a higher quality of life for the 21st century man."

Many young engineers like to work with people and are concerned about their welfare. For these engineers the opportunity to apply engineering know-how to the creative development of the cities is a fantastically interesting and vital challenge.



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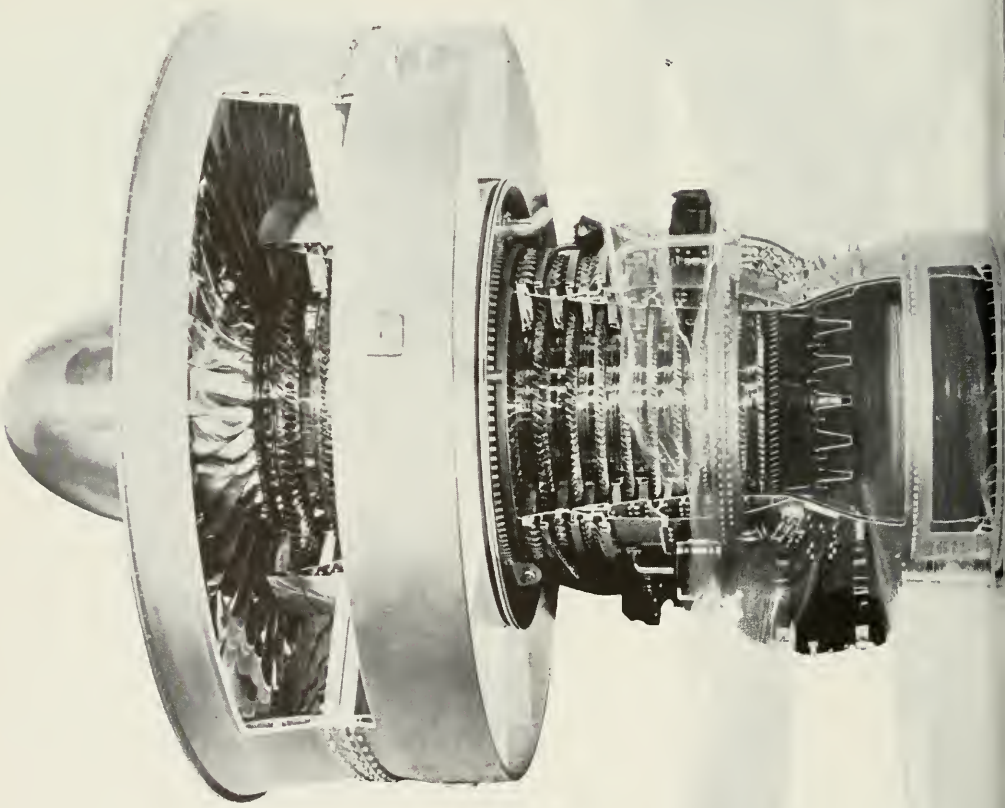

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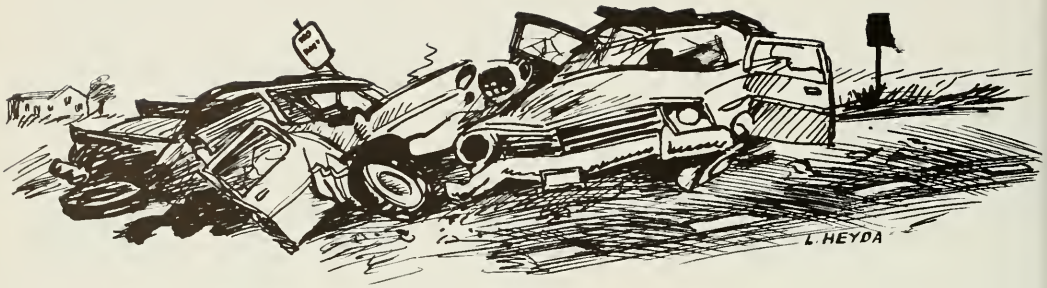

WHERE LIES THE PROBLEM ?

By Jeffrey Kurtz

One of the major causes of death in this country is the automobile. In recent years many attempts have been made to minimize this problem. Dr. Jeffrey O'Connell, a law professor at the University of Illinois, is noted for his activity in automobile safety. TECHNOGRAPH interviewed Dr. O'Connell early this year.

Highway accidents can be grouped under three general causes: human failure, highway inadequacies, and mechanical failure. Each of these has a definite part in the problem, but Dr. O'Connell feels that the major aspect is that of mechanical failures.

He grants that a human can have failings — poor eyesight, limited reaction speed, and especially emotional problems. People often hurry, throwing caution to the wind; or they are upset by other drivers or conditions. Since people will not change, a car should be designed for passengers, not vice versa.

This country has millions of miles of roadways, and continual improvement is a costly and time-consuming task. Considering the safety derived from each dollar spent, roadway improvement is not the most feasible approach to the problem.

This brings up the mechanical solution. There are thousands of cars on the road today, and new cars are being produced each year. Older cars are scrapped at a lower rate than new cars are produced. If cars were constructed to stringent safety regulations they would last longer, be safer, and reduce auto deaths. Rather

Jeffrey Kurtz, a sophomore in Mechanical Engineering from Arlington Heights, is presently the TECHNOGRAPH Engineering Council Representative.

than putting out money to rebuild all of the resources, as would be the case with highway repair, the money should be spent on the new cars. True, this would raise the prices of cars, but the increase would be on all manufacturers so no one producer would suffer.

A possible help to traffic problems could be found in mass transportation. This is a new field and large-scale operations are not yet operable. However, the automobile has come to be a vital part of the American way of life, and it will always be a principal mode of transportation in this country.

Dr. Jeffrey O'Connell continues to point the finger at mechanical automobile failures as the major cause of highway accidents.

What is being done to make vehicles safer? Surprisingly little. Since the highway safety act Detroit manufacturers have generally complied with the government's regulations. However, the improvements have come only with constant prodding, and few ideas have come from Detroit. In some respects, states Dr. O'Connell, manufacturers seem to invite trouble. Cars are being built for speed, and are named for excitement, and power (Mustang, Wildcat, and Cougar, to name just a few). It often appears that the main deterrent to carelessness, offered in cars, is guaranteeing maximum damage for minimum mistakes.

One may argue that he can always get into a hazardous situation, and power is necessary to get out. This is partially true, but power and speed should be differentiated. It is possible, says Dr. O'Connell, to have high acceleration without a top speed of 120 mph. Most states have a maximum speed limit of 70 mph. Perhaps, if necessary safety improvements were made on automobiles, speed limits could more closely approximate automobile capabilities.

The right of the government to regulate features on cars is often questioned, but it should not be difficult to understand. Many things in the United States are regulated. Drugs, weapons, and all other modes of transportation must be inspected and approved before the public is allowed to use them. Certainly it is not unreasonable that a machine so widely used and so potentially dangerous should have the same regulations placed upon it.

The National Safety Council is underfinanced and therefore understaffed. In order to make recommendations to an industry it must have qualified personnel to determine problems and solutions. Unless the council pays salaries as high as the industry it cannot get the necessary talent to advise manufacturers.

The consumers in this country are often said to control what is produced. Dr. O'Connell advises that if people write letters to the manufacturers expressing their views and concern about safety, the problem would probably be attacked by a willing industry.

What is the engineer's part in this situation? Presently an engineer joins a company and does what they dictate; this is the natural union between employee and employer. What is needed is for the engineer to recognize his duty to society as a person whose decision controls the lives of many people. His duty is to design a car that will satisfy customers' wants, while providing for their own good.

No doubt the automobile will continue to be somewhat of a hazard, but with some effort on the part of the manufacturer, the consumer, and the engineer, the situation would be greatly improved.

There's still hope for girls like us Mildred. All we have to do is wait til Friday afternoon, then just stroll through the engineering campus.

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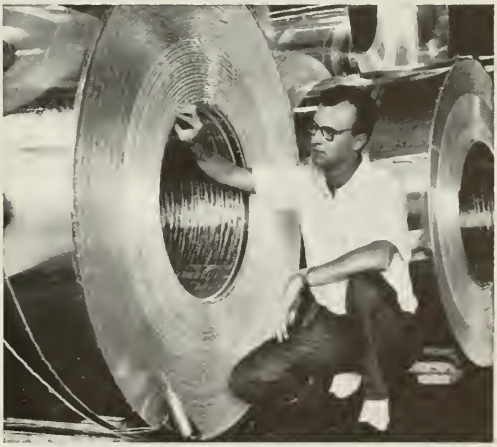
David A. Heatwole (MS Geol., U. of Arizona '66) is a geologist doing geological and geochemical work with an Anaconda exploration team in the southwest US and Mexico.

James F. Lynch (BS Mining E., U. of Missouri, '61) is a general foreman at Anaconda Wire and Cable Company's plant in Marion, Indiana.

Marie C. Vecchione (MS Phys. Chem., Yale '62) is an analytical chemist in Anaconda American Brass Company's research and technical center, Waterbury, Connecticut.



Marlan T. Boultinghouse (BS Geol., Indiana U. '59) is sheet mill superintendent at Anaconda Aluminum Company's plant in Terre Haute, Indiana.

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"An institution may hold itself to the highest standards and yet already be entombed in the complacency that will eventually spell its decline."

John Gardner

"... there is little demand for radical changes in academic programs."

Final Report on the Goals of Engineering Education

TO SEEK A BETTER COLLEGE

by ALAN HALPERN and MICKEY MINDOCK

"An Institution which demands and gets the highest quality in its laboratories has shown itself to be impotent in the face of mediocre teaching in the classroom."

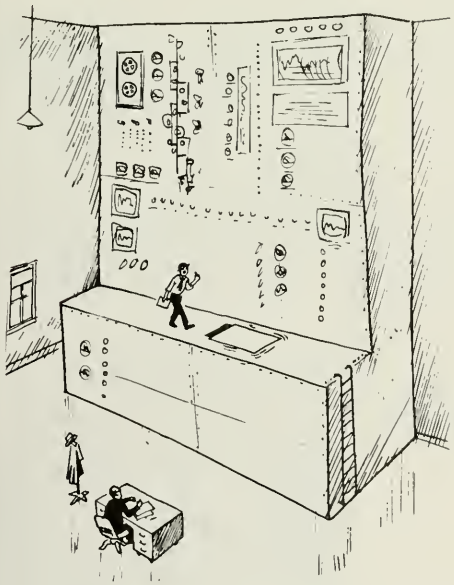
In all likelihood, there is not a faculty member in the College of Engineering who could get a license to teach in most Illinois high schools or grade schools. The fact that an individual has a PhD in engineering generally testifies to his technical competence, but it says nothing about his ability to communicate his knowledge to others and to create enthusiasm and interest in the process. The answer of the Physics Department to the criticism of the TECHNOGRAPH (Dec., 1966) concerning the teaching in the elementary physics courses was basically, "Sure, we want to teach a good course, but we don't know how." How much does the College really care about effective teaching? One of the things that is obvious is that an institution that is renowned for its research efforts is apparently not in the least interested in doing research on its educational practices. This is not only a paradox; it is an absurdity. An institution which demands and gets the highest quality in its laboratories has shown itself to be impotent in the face of mediocre teaching in the classooom.

A great learning institution is a place where experiment and innovation in undergraduate education are strongly encouraged and practiced. The Honors Program has launched some remarkably good courses, but what it learned from these efforts does not seem to be contagious. The atmosphere of excitement which should be found in the classroom is not there; in its place is one that tends to induce apathy, stifle creativity, and encourage reproducibility instead of understand. Instead of excitement, we find boredom. Yet, there appears to

Mickey Mindock and Alan Halpern are two of the College's most knowlegdeable and responsible critics. Mickey is a former President of Engineering Council and Alan is former Editor of the TECHNOGRAPH.

be no real interest for the improvement in teaching or for the provision of an effective mechanism to make it possible. Undergraduate education in the College though generally quite conscientous, often very good, and occasionally brilliant, commands neither the attention nor the status it deserves. It is not a problem which can be solved on an individual basis. A faculty committee at Cornell University has concluded: "Left primarily to the individual initiative and resources, attempts at innovation are neither frequent, far reaching, nor particularly daring." "There are professors," says Paul Dressel, writing in *Issues In Higher Education*, "who knowing full well that they could do better, interpret academic freedom as inclusive of the privilege to teach as badly as they wish."

There is one committee in the College of Engineering on Teaching Improvement. According to the Chairman, the committee has met six or seven times this year, concentrating primarily on video-taping and teacher evaluation in the General Engineering Department. Lacking significant college support and any comprehensive vision and plan for change, the committee has floundered, with the result that its efforts are virtually inconsequential. And yet, this evaluation, the primary one on which the College relies, was assessed by an expert from the Office of Instructional Resources as follows: "The content obviously does not cover many areas that seem to be considered appropriate indices of teaching effectiveness... Did the student feel he learned anything? This area of attitude is not touched upon."



"Gee, Boss, the computer has replaced so many people here, I'm continually surprised that I still have my job!"

An engineering student spends four to five years here before receiving his degree, during which he spends something like 2600 hours in class. It is a small portion of his life, but a most important one; it is at the university, hopefully, that an individual develops his capacity for lifelong learning, where he learns habits and attitudes, where he enlarges his horizons, where he acquires the discipline for critical thinking. As John Gardner observes, "Education at its best will develop the individual's inner resources to the point where he can learn, and will want to learn, on his own."

Because we are concerned about continuing education and do not believe that we are learning the needed habits and attitudes, we have very strong objections to the way our educational programs are being conducted. But we are, concerned with learning, not teaching. Too often, instructors are satisfied to sacrifice enthusiasm for rigor, understanding for fact, perspective for specific. Many think of the mind as a storehouse to be filled rather than an instrument to be developed. It is the students in the classrooms who know if they are learning or not, and as such are the most capable of judging the weaknesses and strengths of both instructors and courses. The students, given the opportunity, can provide specific, honest, and concise comments on whether they are learning or not. They can say whether the course is fascinating, boring, or worthwhile — which is what the individual instructor and the College in general obviously need to know. What the College needs, at least as a first step, is a "good" evaluation, one used not just at the end of a course but two or three times during the semester, so that the professor may have had the advantage of "instantaneous feedback" and may take immediate action to improve his teaching.

The point is that the faculty of the College has not convinced the students that undergraduate education is considered to be of great importance. The present evaluation form of the College is infrequently used and even we admit that it is generally useless. The university has facilities for assisting any department or college that wishes to create an evaluation form. This wouldn't seem to us to be a particularly difficult or expensive thing to do in view of the benefits that might be provided.

"Great buildings and expensive laboratories can never make a great university; great teachers do. One can recognize them by the vision, the inspiration, they give to the men they teach." This was said by Hardy Cross, one of the truly great instructors in the College of Engineering of the past. Professor Cross left the university in 1936 — have we forgotten since then what he knew?

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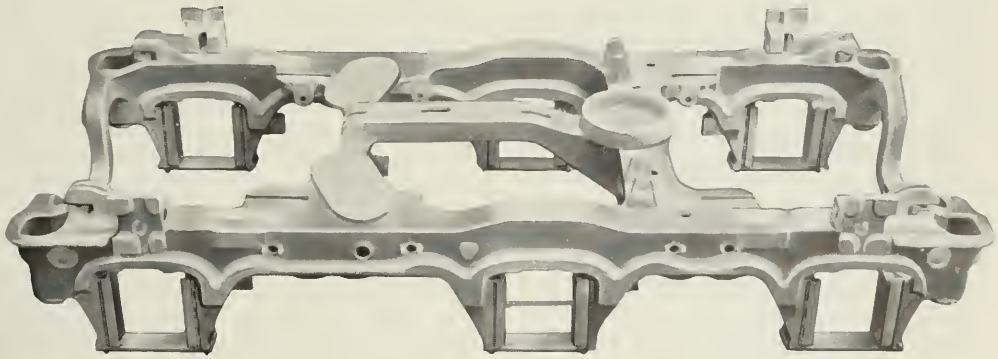

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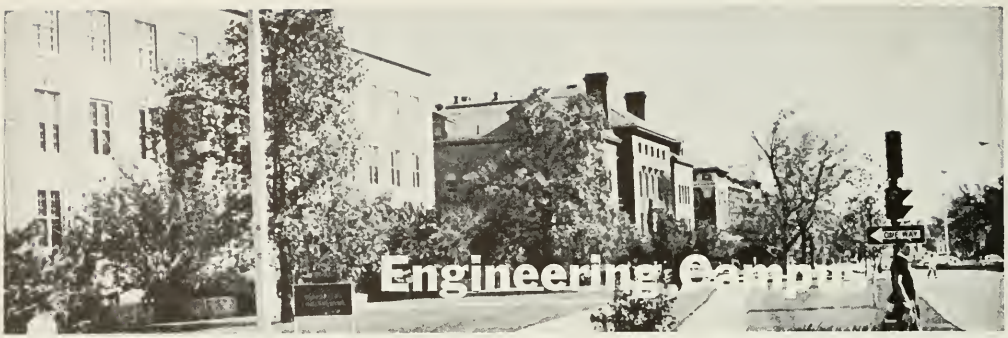


CHARGED PARTICLE RESEARCH

Some of the most interesting research in the Electrical Engineering department is that being done in the charged particle laboratory. It dwells around the study and observation of extremely small charged particles. There are three major areas of experimentation:

1. Ion propulsion for space vehicles
2. Study of the actions of ions on metallic surfaces.
3. General study of minute liquid particles.

The research on ion propulsion is done in the following manner: a tiny jet of charged gallium-indium alloy particles is forced from a needle-like apparatus ane
and electrically directed away from the source at tremendous speeds. The beamwidth, thrust, and kinetic energy of these ions are carefully studied as they speed through the deflection plates. Although these particles are of low mass, their high energy gives them interesting space vehicle applications. With the use of these ion generators as engines, travel through outer space could be made much easier. The ion engines would not be especially useful for direct propulsion, but for balancing the drag of orbiting satellites and steering vehicles their low power would prove very efficient. One gram of gallium-indium "fuel" could keep a satellite in perfect orbit for months.

However, problems in ion engine use give rise to the second type of research being done. This is the study of the effects ions have on metal surfaces. When ions are expelled from an ion engine, they can soon corrode parts of the mechanism and cause serious difficulties. The men in this lab are testing different metals for their endurance against ion corrosion. Such problems are also present in devices as common as tungsten light bulbs and vacuum tube filaments. If a solution to this problem could be found, the life of a vacuum tube could be greatly extended.

The next type of research is perhaps the most representative of the entire laboratory. This is the investigation of properties of many types of liquid particles in general. A device presently being built is one which will be able to suspend a single charged droplet in an electric field for observation. Characteristics such as motion, surface tension, and rate of evaporation can be seen in detail with this machine.

The study of water droplets is very useful. From it we learn how clouds form and how precipitation occurs. At the present, so little is known about cloud formation that scientists cannot even explain how rain forms and falls as rapidly as it does. A better understanding of water particles might lead to uses such as artificial rain making over desert areas.

The lab also studies collision of particles. When a particle of water in the 1 to 10 micron region is generated, it exhibits some very strange properties. For example, its surface tension becomes so high that a collision with another droplet results in an elastic collision rather than a coalition. Great amounts of energy must be put into water droplets of this size to cause simple condensation.

The generation of small uniform globules has dozens of everyday applications. The spreading of insecticides and weed killer is done through the use of tiny droplets. Aerosol sprays, spray paints, and automobile carburetors are all made possible through particle research. Presently Xerox is testing out copiers which spray ink rather than stamp it. Not only is printing of this type done faster, but it is easier to read. A final but extremely important use of particle research might be in the elimination of smog. If scientists can learn more about the formation and properties of smog particles, there is a better chance that we can control this health hazard.

WATER VAPOR LASER STUDIED AT ELECTRICAL ENGINEERING RESEARCH LAB

by John A. Barra

Ever since Galileo first attempted to measure the velocity of light using lanterns, scientists all over the world have continually tried to increase the accuracy of this measurement. Many sophisticated instruments have been developed for that purpose. The velocity of light, which is approximately 3 x 10 8 meters per second, has to date been determined with an accuracy of about one part in 10 6.

However, the interest and scientific value of this quantity have compelled scientists to strive for an even more accurate measurement. Research in the field of lasers resulted in a significant step in that direction. In 1964, a water vapor laser was developed by three English scientists. This laser, which uses water vapor instead of a monatomic gas, produces wavelengths in the far infrared region, a region of the electro-magnetic spectrum which up to the present time has received little investigation. Scientists hope that accurate measurements in this region of the spectrum with the water vapor laser will make possible a measurement of the velocity of light with nearly 100 times greater accuracy than previously achieved.

However, before such a measurement can be made, a great deal more research with the new laser must be conducted. The University of Illinois is actively contributing to such experimentation. Ever since 1965 when the University constructed its first water vapor laser, Professor Paul Coleman of the Electrical Engineering Department has directed extensive research with this laser. In a joint effort with Assistant Professors William Jeffers and Donald Akitt, graduate research studies are being conducted with five laser systems now in operation in the Electrical Engineering Research Laboratory.

A water vapor laser is about twice as long as most lasers. The research team at the U of I is studying the processes which are going on inside this laser. They study things as excitation and relation phenomena in the molecular gases since they are important to any understanding of the laser. The research at the University of Illinois has produced the highest peak radiation intensity ever generated in the far infrared region. Using about four kilowatts of power at 28 microns, Mr. Carl Johnson, a doctoral candidate in Electrical Engineering, is studying far infrared-induced nonlinear effects in solids.

In addition to the possibility of an improved measurement of the velocity of light, the water vapor laser has raised the possibility of other engineering and scientific applications. Coherent radiation in the far infrared region generated by the laser opens a new field of research. Only a few of the many possibile uses for the water vapor laser are secure communications systems, signal measurements, and the study of chemical and bio-chemical reactions. As research continues in this field, many new avenues of study are likely to open.

Professor Coleman, however, has not only studied the wavelengths produced by the water vapor laser, but he has been a part of research of wavelengths of all sizes. Ever since his college years at MIT, Professor Coleman has witnessed and actively participated in the discovery of wavelengths through a great part of the electromagnetic spectrum. At the end of World War II, this field had advanced to the place that coherent radiation at wavelengths as small as 8000 microns (K Band) had been produced.

Between World War II and 1960, this boundary progressed by only a factor of eight. In 1960 a large jump was made due to the progress in Quantum Electronics. In that year the ruby laser was first demonstrated, yielding large amounts of coherent light at 0.69 microns (dark red). However, this discovery left an unstudied spectral region between 1000 and 0.69 microns. This frontier was soon settled with the advent of gas lasers using monatomic gases, ions, and molecular gases. Today, we have scientists like Professors Coleman, Jeffers, and Akitt at the University of Illinois taking advantage of the developing possibilities to study lasers and materials in the far infrared region.

A water vapor laser used in the Electrical Engineering Research Laboratory.

THE X-RAY MICROSCOPE

by Mike Feldman

A microscopic chemical analysis, and in particular, a non-destructive analysis, can be of great value to everyone from metallurgical and ceramic engineers to agronomists and dentists. The Materials Research Laboratory has an X-ray Microprobe for non-destructive analysis of one micron diameter locations on a wide variety of solid samples.

The Microprobe operates on relatively simple principles. An electron beam is focused to a point on the sample, and the atoms at that point become excited and emit x-rays. The frequency of the x-rays is characteristic of the particular element excited. The relative intensity of a given frequency of x-rays from the excited part of the sample is proportional to the precent of the given element at that spot. The Microprobe has three x-ray spectrometers, each of which can be set to read the intensity of x-rays of three frequencies corresponding to three different elements. By comparing these intensities to those of samples of pure elements, the amounts of the elements in question can be calculated to within 1% of actual values for any particular one micron spot on the surface of the sample.

The Microprobe can be used in various ways. It can be used to do spot analyses across a sample with the spectrometers set for a known element and for suspected impurities. In this way one obtains an analysis of structures that are responsible for certain properties of the sample.

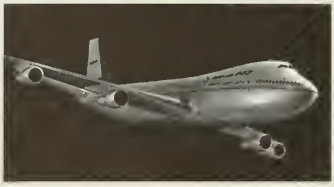
"You you . . . @# engineering clod!"*

The electron beam can also be scanned, and the intensity of a given frequency read out on an oscilloscope. This display can be photographed to give a micrograph which shows the distribution of any element heavier than nitrogen. These scanned pictures can be varied to give from about 50X to 12,000X magnification! Another technique that is often used has a scanning process similar to the above, but counts the number of electrons scattered back from each point. The brightness of the trace is roughly proportional to the atomic weights of the elements present. This kind of picture is used to show the major structural features of the sample and to help determine the composition of irregularities.

These techniques are applied to a wide variety of problems. Much of the work being done with the Microprobe has to do with the study of impurities in metals. The probe is used to find which impurities increase the performance of the metal, as well as those which are detrimental. These studies have already led to improved metal processing. The probe is being used to study the corrosion of ceramic materials under extreme conditions such as reactor cores and metal casting feed tubes. An unusual study in agronomy was done on near-microscopic particles of iron-manganese found in the soil. The migration of certain chemicals into these particles was analyzed, and it was found that the migration was related to the climate the soil was exposed to. Another interesting study was done on teeth. It was found that the concentration of fluoride decreased in the vicinity of decayed spots.

The X-ray Microprobe shows great flexibility and an expanding future as well as a wide range of applications. Besides the counters for quantitative study and the various modes of the oscilloscope output, an analog to digital converter and a magnetic memory are being incorporated in the instrumentation. In the quantitative analysis phase, the bulk of calculations for correction of data is so great that it must be done by computer, and generally the amount of data is so great that the IBM 360 is the only computer on campus big enough to process it. When time share becomes available, the Microprobe operator can feed the data to the computer as it is available, and this would eliminate the need to record thousands of data points by hand and then punch the data into cards. Thus the X-ray Microprobe is not only diverse in its applications, but it is expanding in its capabilities.

"But, of course, I'm in engineering . . . didn't you notice my white socks?"



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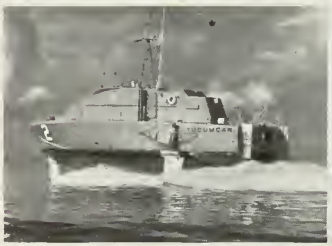

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To The Editor:

Since I have been in charge of the advising program in the College of Engineering for the past several years, I feel it appropriate to comment on your editorial which appeared in the December issue of the ILLINOIS TECHNOGRAPH. I do not write to defend our present advisory system as I think it is one of the strongest on campus but to acquaint you with the present advisory program and with the improvements made within the past several years. After reading your article a number of concerned staff members called and Dean Everitt discussed the contents with me the day it appeared. By and large engineering staff members take pride in the present advising program and are vitally concerned about its effectiveness.

For staff members, participation in the advisory system is one of their many expected duties; however, for students, participation in such a program is purely voluntary. We have been somewhat discouraged by the relatively large number of students who do not wish to avail themselves of the advisory program available. It is our responsibility to provide a meaningful and satisfactory advising system but, on the other hand, it is not our duty to force advisement on the students. Personally, I have been discouraged by the fact that the "Advising System" was to have been discussed on two different dates in the Student-Faculty Liaison Committee (of which you are a member) and on each day not enough students attended to make the presentation worthwhile. Thus it was neither discussed nor studied prior to your editorial.

Before commenting on certain aspects of the system, I would like to point out that all of us — students and staff alike — are interested in making any improvements possible. If this can be best accomplished by having others study our system and make recommendations then we would welcome such participation.

Your editorial states "we do not have a committee to study the tremendous problems of advising" and this is not the case. The Program Committee in the College of Engineering is specifically charged with the problems of advising and registration. This committee has provided real leadership in the past as witnessed by the fact that it established an Advance Enrollment Program in the College long before such a system was adopted within the University. The committee has also developed a number of registration methods and evaluational procedures which have been adopted on an All-University basis. Further, in the past five years no college has made more changes in its advisory program seeking improvement than the College of Engineering.

The College Advisory Program is make up of four major advisement efforts —

(1) advisement and advance enrollment of new freshmen admitted to the College,

(2) advisement and advance enrollment of new transfer students admitted to the College,

(3) advisement of Honors students in the College, and

(4) advisement of all continuing engineering students in the College.

All of these activities are carried on through a departmentally oriented system with the exception of the first area — the advisement and advance enrollment of new freshmen.

A group of special advisers are selected to advise incoming freshmen and advance enroll them during the summer period. These advisers evaluate the student's high school background and use the results of a variety of placement and ability tests to place the student in courses commensurate with his ability and achievement. The advisers have been trained to use a high degree of personal judgement in their evaluations to insure that students are not placed in courses too advanced for them but at the same time at a level at which they will not be required to repeat work previously taken. All measurements of this program indicate a high degree of success in placing incoming students both in terms of their performance and in terms of their personal satisfaction.

The evaluation, advising, and registration of incoming transfer students requires a very high degree of personal attention and individual placement. The evaluation and registration of transfer students is handled by our most experienced advisers in the College, all of whom have been trained and are capable of evaluating transcripts from other schools. At the time of transfer a degree evaluation is made on each student so that he has a clear understanding of the requirements remaining for graduation. The transfer students are advised by a staff member from their major area in engineering.

The College Honors Council has taken the responsibility of providing a meaningful advisory system for honor students and the honors advisory system is well coordinated with the total college advisory system. As a part of the College Honors Program, the honors advisor has been given considerable freedom in making course substitutions and providing other special opportunities for honors students. The article "The Honors Program in Perspective" in the January issue of TECHNOGRAPH indicates a fairly high degree of satisfaction with the honors program and with the advising methods.

By far the largest effort is that in the advisement of continuing students in the College who do not fall in one of the other areas mentioned. The advisers have been charged to bring to the attention of each student opportunities which exist both on and off campus. Further, they are responsible for advising the student regarding degree requirements, course changes, selection of electives, and can be instrumental in helping the student to formulate variations in his program which can be approved through petitions.

The first of the four areas listed above is administered by the Associate Dean's Office directly. But the latter three areas are primarily the responsiblity of each department within the College of Engineering. We have established in each department an advising leader which we refer to as the "Chief Adviser". The Chief Adviser is responsible for the departmental advising program and is expected to make adviser assignments, evaluate new transfer students, implement curriculum changes and course changes, evaluate special student requests, and serve as a general trouble shooter for the department.

All engineering students are assigned to individual advisers and they are informed of this assignment either by mail or through the posting of lists on college and departmental bulletin boards. Advisers are continually informed of the student's progress through updated copies of his transcript and graduation requirements, course change notices and results of petition action.

In the past five years some of the changes that have been made are a complete rewriting of all adviser guidance materials, establishment of regular meetings with advisers throughout the College, development of a data system to provide all advisers with extensive up-to-date information regarding their advisees, a feedback system to determine the effectiveness of our advising program at the freshmen level, and all advisers have been asked each year to criticize or suggest ways in which the advising system might be improved. Four years ago we asked each graduating senior to evaluate our advising system and give suggestions for improvement. Each year since that time we have sought the advice of our advisers to improve the system. In each case, changes have been made based on these evaluations. Thus, there has been more than an occasional measure of the success of our advising program as indicated in your editorial.

Three years ago an "Adviser's Manual" was developed which outlined the specific duties of an adviser as well as information on special opportunities to be brought to the advisees attention. This Manual, a copy is enclosed, has encouraged at least two other colleges on campus to develop similar booklets.

Many might not think of the Engineering Placement Office as a part of the advisement program but it is an important portion of the advisement a student receives. Through this office he is assisted in the selection of his first professional employment and many students also gain summer work experience opportunities through this source. The Placement Office provides extensive information on opportunities available.

I realize that there are some difficulties in our present advisory program but believe your statement that "few are satisfied" is too broad. Perhaps a definitive article in TECHNOGRAPH on the advisory system might provide students with a better understanding of the system and improve both student and staff response. Further, I would suggest that Engineering Council, or its appointed group, make a study of the present system and make recommendations for improvement. Constructive criticism is certainly welcomed.

Cordially,
H. L. Wakeland
Associate Dean

In Reply:

Your office is to be commended for its work in improving registration methods and evaluational procedures within the College. Every advisor is equipped with the latest in statistical evaluational techniques and counseling manuals. However, an advisor is only as good as the guidance he gives his students. If the student and his advisor seldom meet, it is doubtful if the advisor can be called a good advisor. The fact is, advisors and advisees seldom meet, few advisors really know their students, and our well-structured, greatly admired advisory system is just not doing the job.

Unitl a way can be found to establish closer ties between advisors and advisees, students will continue to not avail themselves of the advisory program. Only through real friendships will conversations flow easily, problems be solved, and students begin to fully utilize the knowledge and resources of the advisors.

You state the problems of the advisory program were neither discussed nor studied prior to the December editorial. This is not true. Many hours were spent interviewing students and the consensus was that most students do not look to their advisors for guidance. It was then that TECHNOGRAPH proposed that a professional study of the advising program be made. The fact that TECHNOGRAPH did not first approach the Student-Faculty Liason Committee before printing its proposal is not critical. This is especially true when one considers that at the February 22nd meeting of the Committee, the advising problem was brought up, TECHNOGRAPH submitted its proposal, and not one member of the Committee commented. In fact, at the same meeting a vote was taken to decide areas of study for the semester and advising was rejected.

Several Honors' advisors have, indeed, been able to communicate with their students for one very good reason. Because the honor's advisor has the power to make course substitutions, he become immediately attractive and useful to the student. Consequently, the honors student consults his advisor even if a personal relationship does not exist. In a sense, with his power the advisor has lured the student into his office. On the other hand, non-honors' advisors do not have the freedom to make course substitutions. They must find some other method to develop friendships with their advisees.

Do we need to give more advisors the power to substitute courses? Should advisors attempt to develop a relationship with students by making their first few meetings compulsory? Should the manner in which advisors first approach new advisees be analyzed? We do not know the answers to our advising problems, but we are convinced the answers do not lie in improved counseling manuals or refined registration and evaluation methods. Once again, TECHNOGRAPH proposes that a professional study of the advisor-advisee relationship be undertaken.

Advising is and will continue to be a personal matter.

TECHNOGRAPH STAFF

To The Editor:

In the January issue, Edwin Black gave the engineering student some suggestions for crossing Green Street. The idea, as I gather, is that by spending all of one's time or all of one's interest on one side of the street that you become less of a total human being and more of a machine. I agree wholeheartedly. I suggest as a first step in remedying this situation that all non-engineering students be required to take GE100 and then to choose 12 credit hours of courses from a list of engineering courses of general nature.

I think Mr. Black is going about his cross-over in the wrong direction. I believe that most engineering students know and understand more about the South side of Green Street than vice versa. As a senior in Civil Engineering I have taken courses in History, Political Science, Psychology, Economics and Geology not to mention the Rhetoric, Chemistry, etc. that are required of most students. These courses are in the general stream of LAS curricula and more in line for history majors than engineers. However, I have yet to see an English major in any of my TAM courses and none have appeared in any CE courses. The imbalance of understanding is quite as Mr. Black indicated, but his suggestion tends to apply the means for correction to the wrong side of the street.

A great many of his comments were well aimed. We engineering students are technically oriented. We have to be to survive. It is true that the average engineer does not want to study a foreign language or literature, main tenets of LAS, but how many Lit. majors want to study Pavement Design or Soil Mechanics? True, the comparison is not quite fair, but it illustrates the point that many engineers who really want to take courses south of the Great Divide would like to make: If you want to graduate in four or even five years you can't take the time. It only takes one or two "busy work" courses to make that extra humanities course with seven assigned books almost impossible.

The comment that there are fewer engineers in extra-curricular activities is well taken. Generally, we don't have either the time nor inclination for we are busy, as you say, gobbling whole heaps of knowledge and training. But, in our defense, if you were to compare the number involved in some activity on a percentage basis I am sure that you will find the engineer holding his own. It is often assumed that half the campus is engineers, but as I understand it we represent only about one-quarter at most. And even then who is to say that the student who places studies over activities is hurting his future and his intellectual well-being?

The engineering student is being pushed hard to keep up with the rapidly advancing technological world but I don't think without some regard to the total human being. The best solution I can offer is this: Edwin Black, let's both cross Green Street: I'll show you what interest me in CE and you show me what keeps you in the English Department.

Thomas B. Berns

To The Editor:

I'm writing this in the interest of clarification and in defense of a class of students; a class contrived, and in a sense condemned by individuals who choose to believe that people who go to make it are in some way innately different from themselves. I am referring to the people "North of Green street" who, apparently in the minds of some, seem to be capable in their own restricted spheres of enlightenment and interests, but who fail pitifully when challenged to participate in intellectual gymnastics with fellow students, not of the Engineering College.

First of all, it seems unreasonable to me to refer to these students as "the engineers" for we are all men, and not one of us is exactly like another. Moreover, I tend to think that the characteristics common to the whole of mankind are more diffuse throughout this group than some may care to recognize. This is an assertion with which many, I should think, would agree.

Still it cannot be denied that there is a real difference between the engineering and non-engineering student. This difference is not, however, one born out of some deeply rooted mental or psychological schism separating the two, but, in my opinion, is simply due to a relatively minor variation in their individual cultivated interests. What, to my mind, many people fail to recognize is that there is no real hierarchy of status among those things which go to make up the world, its history, and future. Those events and eras in which mankind has been involved are not all that could be called the World. Man is not the point on which focuses the divine gaze of eternity, nor is any other facet of being which comprises existence. If we can remove those romanticisms which color our thinking we can see that there is a Universe of worlds within our own, each worthy of investigation, each as extensive as the next.

That an engineer studies physical aspects of existence is no more unusual or narrow of mind than a humanist's study of the human aspect of existence. Is it not true that a strict humanist who condemns an engineer for his narrowness of range is himself guilty of the same narrowness? Let me hasten to say that I don't believe there exists what I've referred to as a strict humanist just as I must say there is not such a thing as a "pure engineer."

Because I recognize that the term "engineer" has come to mean more than it should I do not like to refer to myself as such. I will only say that I, as is everyone, am a man of many interests, one of which simply predominates. It would be to our benefit that in recognizing our differences we be aware of our likenesses as men, for all men though different are alike.

Respectfully,
Leo G. Dewey
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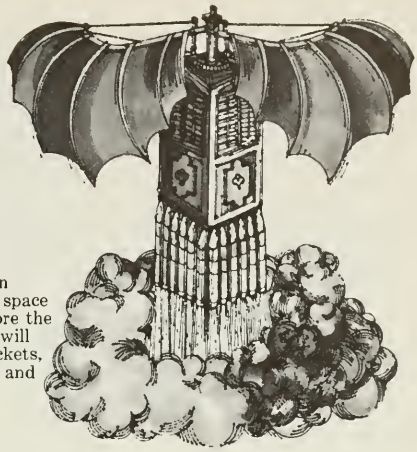

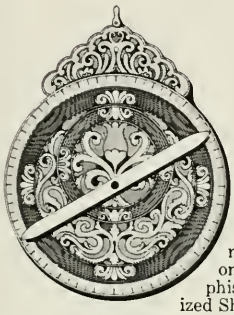

17th-Century Space Flight. Cyrano de Bergerac's science fiction fantasy about a box propelled into space by rockets came close to fact. Before the end of this decade, Apollo and LM will indeed be thrust to the moon by rockets, guided by AC Electronics guidance and navigation systems.

Navigation, Second-Century B.C. Hipparchus's second-century astrolabe was used for celestial navigation until the mid-18th century. Today, ships still depend on stars for guidance . . . through such sophisticated help as AC Electronics' computerized Ships' Self-Contained Navigation System.

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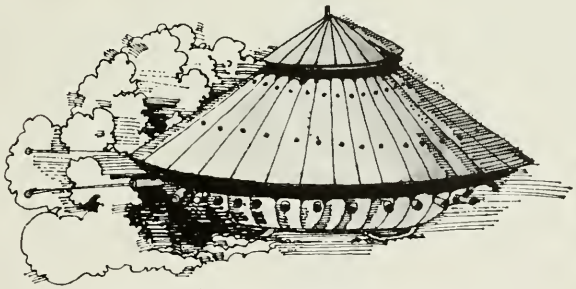

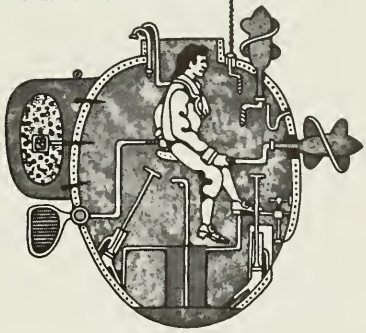

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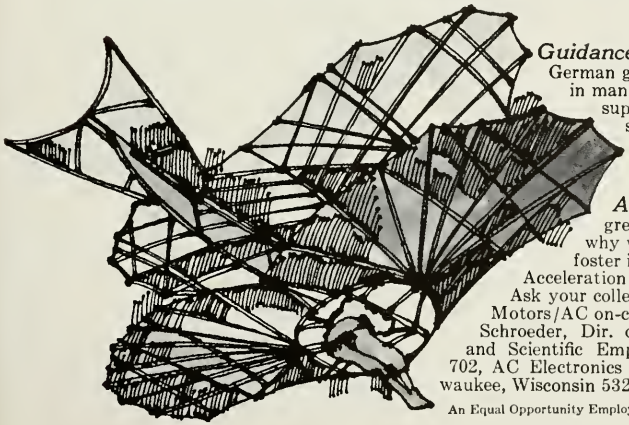

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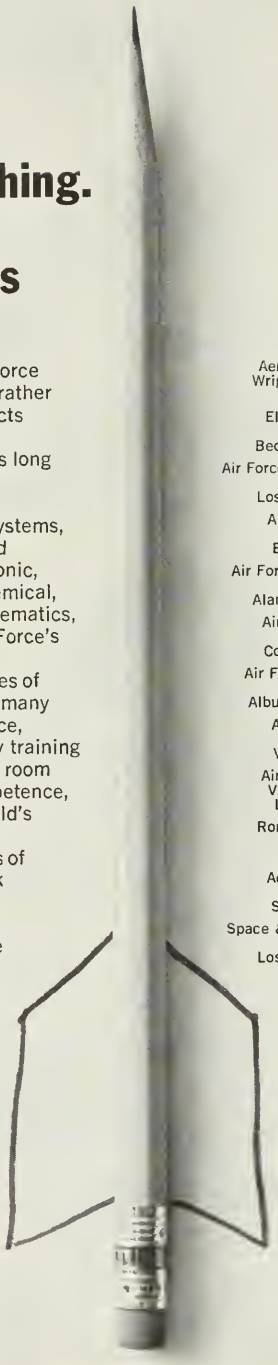

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John C. Heiman, a typical Kodak industrial engineer

Elwood R. Noxon, a typical Kodak industrial engineer

What was crucial six months ago?

Hard to remember.

Six months is a long time to a Kodak industrial engineer. Much happens. Men like these carry on as if the whole company—top to bottom and stem to stern, cameras to industrial adhesives, food emulsifiers to check microfilmers—were a big laboratory for the practice of industrial engineering under the best of conditions. Management finds it pays to let them think so. Happy, they make their advance as strictly professional industrial engineers or hide their industrial engineer's insignia and use their skills to take over other functions in the organization.

Apart from the common denominator of an employer that appreciates industrial engineers and can always use more of them than we get, Heiman and Noxon lead very different working lives. Without assuring these gentlemen against the possibility that six months hence they will have traded specialties, here's the contrast:

Heiman is an accomplished simulation man, a thinker in Fortran, a builder of models for the big computer to manipulate.

He made a good score lately when given six weeks to overhaul the reasoning behind the design of a chemical manufacturing system that had evolved over the last five years as a multi-channel processing plant with problems in line interference and flexibility. He and a colleague, checking each other, spent three weeks writing a program that covered building size, reactor size, product flow, and auxiliary equipment. Debugging took another three weeks. All the while a third man was collecting experience data from the old production area.

The experience data were converted into Monte Carlo input distributions. Various configurations of the proposed production equipment were studied in thirty computer experiments, each simulating twelve weeks of operation.

Result: a system costing 3% more than the original but with 25% more capacity, plus proof that certain manifold connections between reactors wouldn't work.

Noxon works on mechanical goods. He pities industrial engineers who don't get to collaborate with their mechanical engineer partners right from when a project still consists of only rough sketches. He does get called into his projects that early.

His place is in the middle. At his extreme left is the design engineer who created the product idea. Next sits the manufacturing engineer, devising ways for the production boss to transform the idea into reality at the required volume. To the quality-control engineer at the other end of the table is entrusted the whole reputation of the company as it rides on the proposed new product. Between him and Noxon, the production boss awaits instructions. Noxon's job is to sell cost awareness right and left. Unless each of the five gets in his licks, there will be trouble.

Noxon can't stay in the conference room all day. The action is on the factory floor. In putting together job designs, learning curves, and space requirements for the 1970 line, he cannot ignore the ongoing commitment to 1969 product and the lively remnant of '68 production. And cost reductions had better continue when Noxon and his teammates study the "audit assembly" movies from initial production.

Industrial, chemical, mechanical, and electrical engineers who find their profession interesting and would like to practice it in a way that best suits their individual makeup should talk to **EASTMAN KODAK COMPANY,** Business and Technical Personnel Department
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Dan Johnson has a flair for making things.

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The project was part of Dan's work with VITA (Volunteers for International Technical Assistance) which he helped found.

Dan's ideas have not always been so practical. Like the candlepowered boat he built at age 10.

But when Dan graduated as an electrical engineer from Cornell in 1955, it wasn't the future of candlepowered boats that brought him to General Electric. It was the variety of opportunity. He saw opportunities in more than 130 "small businesses" that make up General Electric. Together they make more than 200,000 different products.

At GE, Dan is working on the design for a remote control system for gas turbine powerplants. Some day it may enable his Moroccan friends to scrap their solar cooker.

Like Dan Johnson, you'll find opportunities at General Electric in R&D, design, production and technical marketing that match your qualifications and interests. Talk to our man when he visits your campus. Or write for career information to: General Electric Company, Room 801Z, 570 Lexington Avenue, New York, N. Y. 10022

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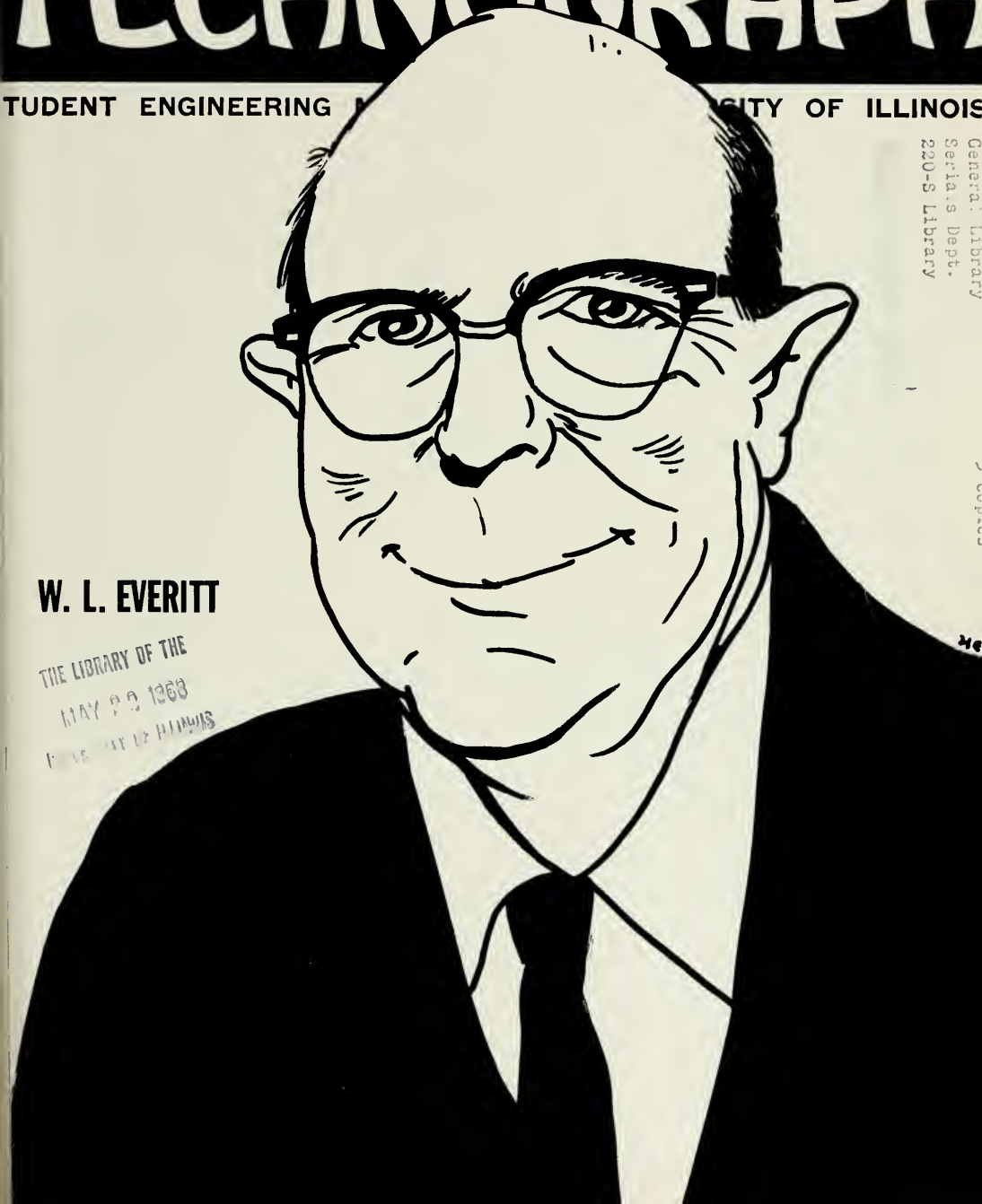

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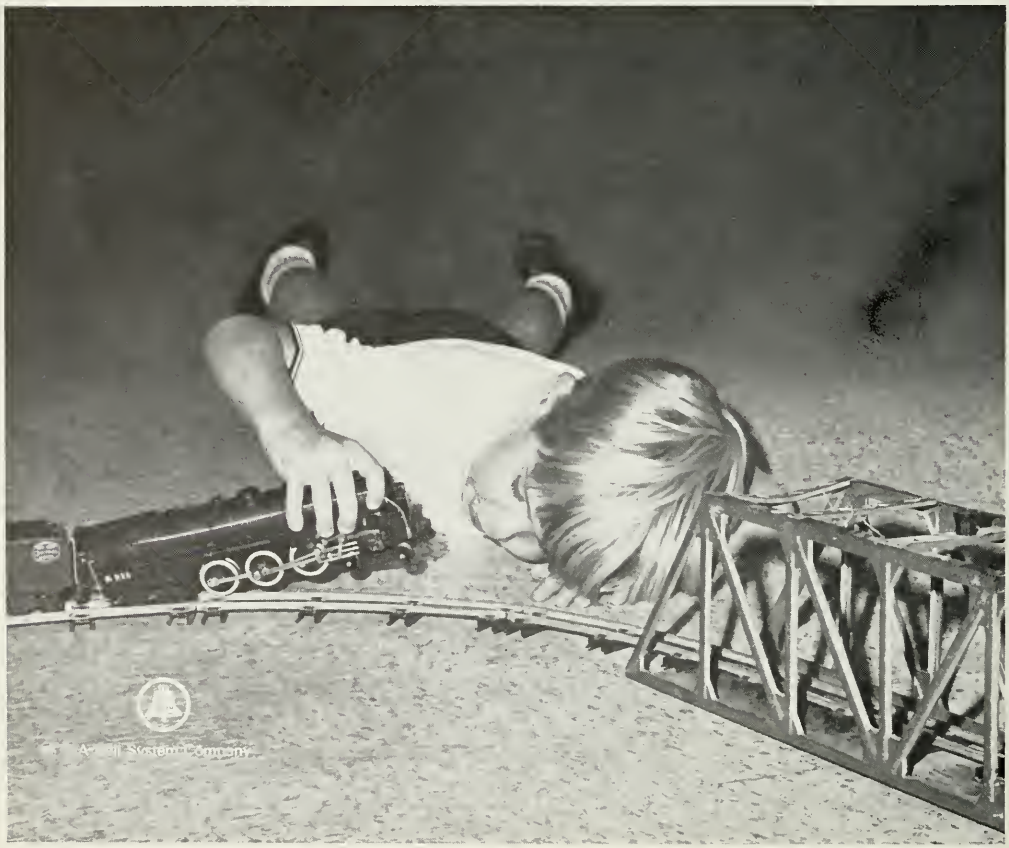

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Western Electric gets a fast fix on magnetics.

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The same engineer who devised *that* hysteresigraph recognized the possibilities of a newly developed device called an electronic operational amplifier. He designed a new, all-electronic hysteresigraph around it that draws accurate curves in about five minutes, needs hardly any adjusting, and is completely indifferent to vibration.

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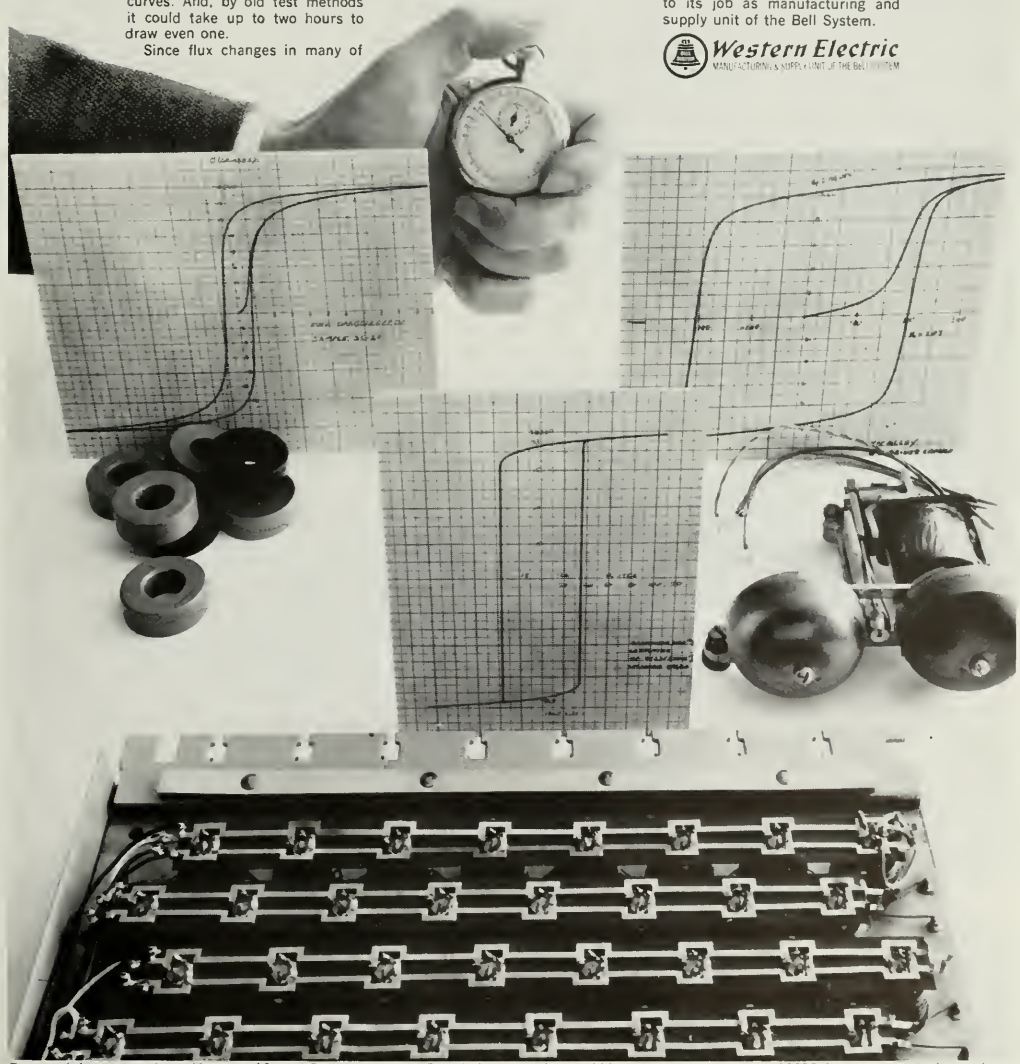

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ARTICLES

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TECHNOGRAPH reviews an illustrious career as Dean Everitt retires.

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Retiring Dean William Everitt as sketched by Larry Heyda, TECHNOGRAPH artist.

editorial

Being the Dean of the College of Engineering must be a lonely job. It requires planning, decisions, and, surely, many regrets about things that could have been done better. It does not permit an overwhelmingly strong relationship with the students, because the voices of the faculty members are louder and because not many students have the nerve to air their complaints to the top man.

For the last nineteen years, the top man has been W. L. Everitt, who became Dean of the College of Engineering in 1949 — between World War II and the Korean conflict. It was a time of flux for engineering education. There were many signs that engineers who had received the traditional machine shop — foundry — nuts-and-bolts education were finding it difficult to stay abreast of the rapid changes of technology. Also governmental agencies were becoming interested in offering financial support to basic research efforts that could produce new knowledge and more engineering Ph.D.'s. The overriding questions were: How could broader, more fundamental programs be designed, and how would it be possible to engage in governmental research efforts without completely sacrificing the goals of engineering education?

Under Dean Everitt's leadership, educational programs were broadened and made more fundamental, and the research programs were increased from their pre-Korean war support to millions of dollars annually — and Illinois' graduate programs in engineering grew proportionately. Not wishing to lose contact with his students or faculty members, the new dean declared an "open-door policy" for his office, an offer that was taken advantage of over the years more often by irate people than happy ones.

Possibly exhibiting something of the masochistic side of his nature, but claiming that he did not wish to lose contact with the students of the College, he made it clear that he welcomed students' opinions, and he solicited the help of Engineering Council and TECHNOGRAPH. He got what he asked for: these students attacked such things as the Honors Program, the advisory system, and the fact that there were no students seated on the College's committees — and he listened. The Honors Program was redesigned, the advisory system was revised, and students were seated on most of the College's committees.

Dean Everitt has had many national achievements. He has been president of all of the major engineering organizations you ever heard of (ASEE, ECPD, COEE, IRE) and a few that you haven't heard about. He was a founding member of the National Academy of Engineering, and he has received more awards, medals, and honorary degrees than most of us would believe possible. But we honor him for local, small, perhaps even Mickey Mouse achievements: he has listened to and respected the opinions of the students of his own College.

We think the next Dean, whoever he may turn out to be, has a big pair of shoes to fill.

W. L. EVERITT

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Exerpts from "THE INEVERITTABLE CONCLUSION", presented April 18.
Edited by Donna Erwin.

In the year of his retirement, we present a picture-history of the life of our Dean....

"the unforgettable man" – w. l. whatshisname

Bill Whatshisname was born April 14, 1900, in Baltimore. This has made it easy for him, as a man who has never been especially good with numbers, to remember his age from year to year.

Even as a child one could see evidence of the foresight that would make him great. He was the first hippie.

Later on his family decided he was a boy.

In 1918, overcome with patriotism and a suspicion that his name might come up any day, he enlisted in the Marine Corps as a private.

In 1922 he was pleased and surprised to be commissioned as a 2nd Lieutenant . . . in another outfit — the Army Signal Corps.

He also got his first degree in 1922 — from Cornell University. He met Dorothy there.

The trousers he wore to graduation had one of those new-fangled zippers.

It didn't work very well.

One day Dorothy showed up for a picnic dressed like this...

She brought some friends...

What a nice surprise!

After the wedding they went to a nice place...

and dressed like Bonnie and Clyde while they were there.

In 1926 he got his second degree — this time from the University of Michigan. He still had the same trousers.

In 1933 he got his third degree from Ohio State.

Although they had three children, they collected pets...

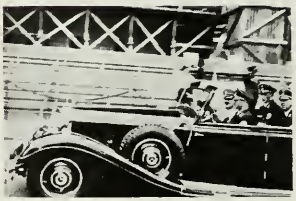
of all kinds.

As Dean, he began to lead the College toward the study of more basic fundamentals...

helping it get more modern facilities...

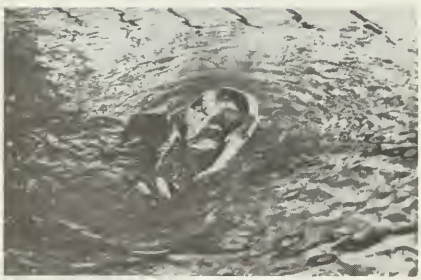
and caused this to be built — whatever it was.

He was very good at getting money for the College.



Over the years he remained involved in various military and government organizations. Here he had a mustache.

He even tested new Air Force planes . .



with occasional bad results.

He became a familiar face . . .

In many engineering organizations.

Although he started at the bottom . . .

In some of them he became quite high.

As Dean, he always liked the students. He especially liked talking to freshmen.

He always had a pleasant smile for students, even when they objected to his policies.

But he was not a pushover when they got out of hand . . .

and Dorothy always stood by his side.

But the Dean was best known as a warm human being who would always try to help students who got into trouble. If and when he could have the right sort of conversation with the miscreants' father, he would offer forgiveness....

and celebrate in his own way after they left his office.

We will never forget Dean Whatshisname.

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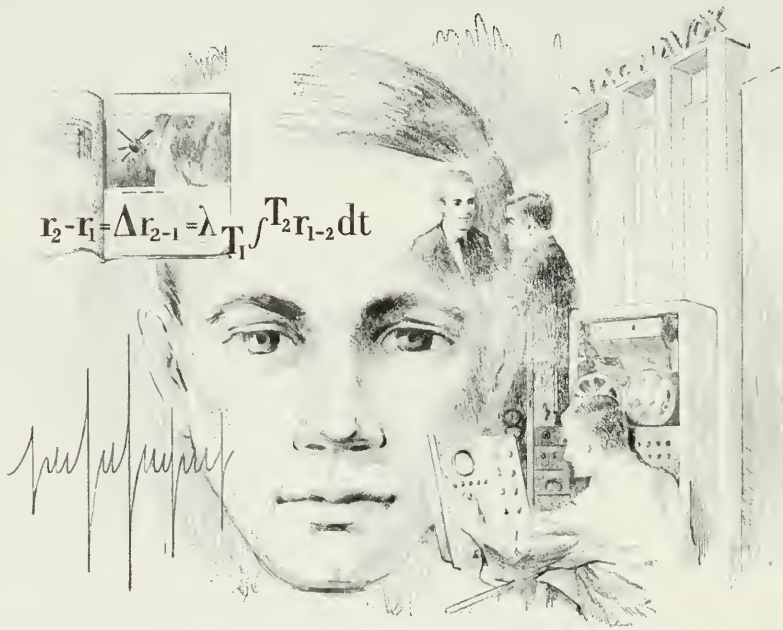

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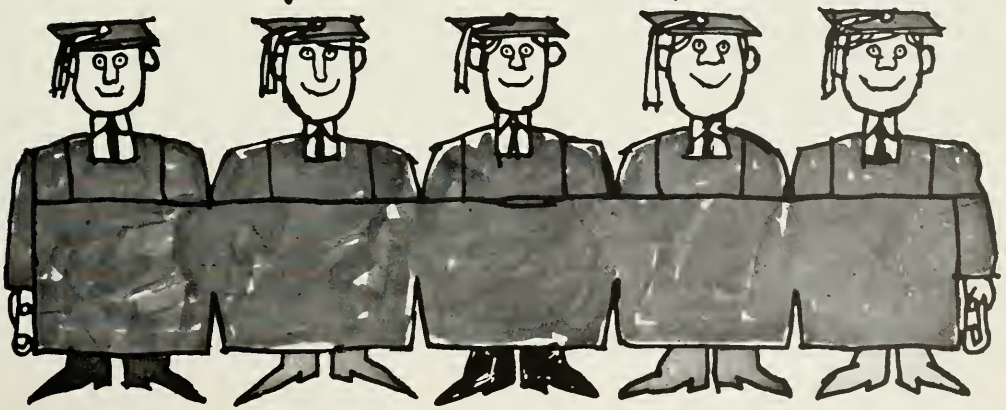


BAYNE

GORDON

UNTIL WE ALL SHALL WORK AS

"The First Teacher Award"

In alphabetical order, they are Associate Professor James Bayne, Mechanical Engineering; Instructor John P. Gordon, Electrical Engineering; Professor Wallace M. Lansford, Theoretical and Applied Mechanics; and Assistant Professor Shung-Wu Lee, Electrical Engineering. These four were selected by the students to receive highest honorary recognition for teaching excellence. Bayne, Gordon, Lansford, and Lee are the first recipients of the Engineering Teacher Award. The teachers formally receive their awards at a banquet May 2.

This project was in the planning only a semester ago. Since that time the Engineering Council has worked with the idea constantly in an attempt to make it operational for this semester. A committee of five councilmen — Al Decho (chairman), Ray Rossbacher, Jim Skogsberg, Joe Stephano, and Dave Turner — was charged with devising a system of fair teacher evaluation and implementing it. After months of debate an evaluation formula was agreed upon.

Two thousand, four hundred engineering students were polled; sophomores, junions, seniors. Each one received a survey sheet with spaces for two nominations or more, if desired. Those who signed their names were assured of complete anonymity. The committee received nonimations for over 150 different teachers. A weighing system was determined, based on a ratio of the number of students a teacher had over a two-year period against the number of nominations he received. Therefore, if a teacher taught only 100 students in a two-year period, ten votes for him would equal 100 votes for a teacher that had taught 1000 students in a two-year period. All but fifty teachers were eliminated.

A questionaire was supplied to each student presently enrolled in the classes of the fifty teachers. Seven questions were asked. They covered areas of teaching techniques, instructor attitudes, and over-all ability. The questions could be answered to indicate any of five degrees of excellence. The most excellent response to a question would make it worth five points and

LANSFORD

LEE

ONE TOWARD A MUTUAL GOAL

by Edwin Black

progressively lower to a single point for a poor rating. With each question worth a possible five points, a perfect score would have been thirty-five. The highest score attained by a single teacher was 34.1. The same weighing system was employed to make scores relative to the sizes of the classes. Of the fifty teachers there were twenty-two that scored far above the rest.

The remaining twenty-two teachers could each have been a winner. Al Decho said, "It was extremely difficult to pick one from the twenty-two superior nominees we had. This was the hardest part of the entire evaluation. We elected to award four teachers instead of just one. Even with this modification the final selection was a problem." Each of the twenty-two teachers was reviewed on an over-all basis. Taken into consideration were specific remarks made by students on the questionaires in the area provided, areas of comparative excellence in the ratings, the weighing system, and the consultation of the various student engineering societies. Finally, four men were chosen as the most outstanding in the over-all opinion of their students, the committee, and the student societies.

Bayne — "I'm overwhelmed. It's really gratifying." Wakeland — "This is the first formal honor from the students bestowed upon their teachers." Bokenkamp — "...and it's one of the best things for the college..." Gordon — "In my opinion this is the ultimate recognition from the student." Opperman — "...a great award of honor and recognition..." Jeff, an electrical engineer — "These are really among the best teachers I know; I'm glad they got the award." Lansford — "This is a high honor coming from the students. They're the ones that really know if you're really teaching well." Ron, a mechanical engineer — "... think it's about time we engineers showed some appreciation for the way we are taught." Lee — "I can say I did not expect this. But I am very happy. Very, very happy." Decho — "We thought it would demonstrate that the students are concerned with the way they are taught. I think it will serve to bring the

Al Decho and his committee are shown here counting the votes.

students and the faculty closer and make each more conscious of the other." Smoller — "We feel this can possibly shorten the existing gap between the faculty and the student body. Of course, it was extremely difficult to pick these four..." Mark, a theoretical and applied mechanical engineer — "I couldn't vote, but I can say that if I would have, that at least one of the winners would have been my choice. Over-all I'd say these four really deserve the honors they're receiving." Craig, a general engineer — "Having been in the college for four years, I can say that the selections look fair as well as accurate. Matter of fact, I voted for Bayne, myself. .

"I'm overwhelmed," said Associate Professor Bayne. Having earned both his B.S. and M.S. at the University of Illinois, Bayne began teaching courses in machine design in 1947. He teaches courses in machine design presently and credits his success to the following attitude; "The keynote is flexibility. I believe that if at first you don't succeed you should try again. Your explanations aren't worth a penny if the students can't understand them. And if the students can't understand a particular concept there is no use going on; it only means they'll understand the next concept that much less. Therefore, if one approach to a concept does not reach the other, by all means try others until you have either exhausted possible approaches, or (as we hope) gotten through to the class."

Of course, sometimes the teachers enthusiasm for his students can be discouraged. "Picture the first day of class," says Bayne. "You've just explained the requirements of the course and the grading system. You covered just what will be expected of the student and when. And when you're done you ask if there are any questions. Invariably, the first hand will inquire, 'Now that I know what you expect, sir, do you know if there are any other sections in this course at this hour.'

"But on the whole I can say that I have really enjoyed my students. I hope that I have been a good influence upon them." We hope so; some of his best students were Jack Hering and Carl Larsen.

"...ultimate recognition from the student," said Instructor Gordon. Although he had received his B.S. and M.S. at Virginia Polytechnic Institute, he chose to work for his doctorate at the University of Illinois. He came here in 1965 when he began teaching courses in introductory circuits. He now teaches circuit analysis courses. Gordon says that in his classes so much depends upon the students enjoying the lectures; "...therefore I usually insert a certain amount of levity into my lectures. Of course, the test of the lecture is in the class participation. I demand that everyone participate in class discussion.

"Not all teachers are interested in teaching students. Some are actually concerned with only their research and consider teaching a chore. Others are really concerned with their role as a teacher. Therefore this means so much to a man like me who likes young people and enjoys teaching. I hold this student recognition far above a departmental recognition, which really doesn't reflect the attitude of the students at all." Gordon's approach to his classes is simple and straightforward and can be best summed up by his statement, "You can't be successful unless you enjoy what you're doing. And unless you're having fun, it seems there can be no enjoyment."

"This kind of thing can be a real incentive to the rest of the faculty," said Professor Lansford. Lansford was born in 1900 and earned his three degrees at the

University of Illinois, and had joined their staff in the experimental station by the time he was twenty-nine. In 1929, his courses were introductory phases in the Theoretical and applied mechanics. Today he teaches courses in fluids. "My basic theory on teaching is that work is demanded of any student if he is to learn. And when a fellow gets a credit from one of my courses you know he's worked.

"If I have an approach it's this: The first four to six weeks is important. That's when you have to set the pattern of what the work is. If you're gruff the first six weeks, you can bet the rest of the semester will run smoothly; it's only then that you can ease up. In my class everything in the lectures and everything in the text is the student's responsibility. Impress this upon them at the start and there won't be a need to growl at the end about being way behind."

Lansford's only criticism of the teaching system today is the practice of distinguishing between honors and non-honors classes. He feels removing all the brighter students is an actual setback to the slower students who need a sense of competition. "I don't like the idea of separating the bright ones from the slower ones. I don't believe in intellectual integration or segregation. If you just leave the classes alone you will get a nice proportion."

To his credit Lansford has almost forty years of teaching. Out of his classes have come many fine students that have been quite successful. Several of his students have become vice-presidents of firms like U.S. Steel or Western Union. In addition, Lansford has the distinction of having taught about a half of the T.A.M. Department, and men like Roberts, Kessler, Murdock, Mosborg, Briscoe. In his hydralics class of several years ago he boasted his best student to be James Bayne.

"This is significant because no one knows if a teacher is teaching well or not. Most teachers spend much of their time in research and pay little attention to teaching," said Assistant Professor Shung-Wu Lee. Coming to America in 1962 with a B.S. he had received in Formosa, Lee earned his M.S. and Ph.D at the University of Illinois. In 1967 the twenty-eight year old electrical engineer received a position with the faculty. He teaches circuits.

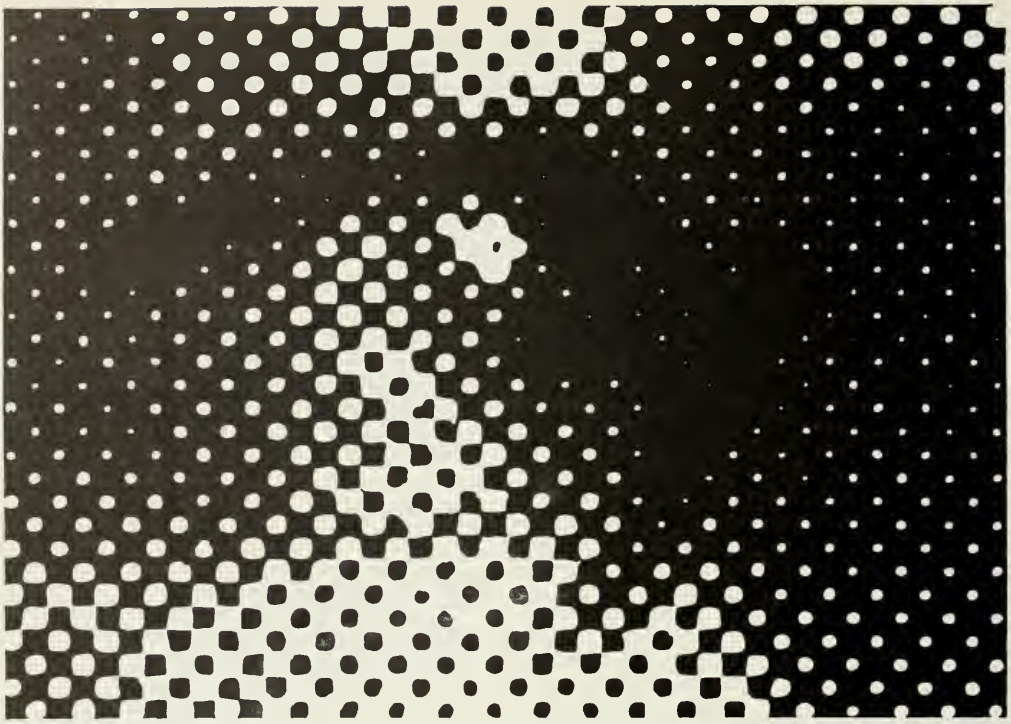
"My philosophy of teaching has appeared to be successful. First, I discourage class note-taking. I feel it distracts from actual teaching and understanding. I prefer my students to pay careful attention and ask about anything they don't understand. I also follow the text closely to minimize the necessity for note-taking. Another practice I find extremely helpful is to memorize the names of each of the class members; I do this within a few weeks after the beginning of the term by studying a seating chart. And if the students should fall asleep during one of my lectures, which can happen, I sometimes tell a funny story to regain their attention."

One of Lee's greatest problems in achieving success as a teacher was in overcoming the worries he had about his foreigh accent. A native of China, Lee felt his accent would be a handicap and actually work against his efforts. "But after speaking to the department head, Professor Jordon, I was convinced my accent might actually be an aid. He told me his best teacher used to be a stutterer. Because both a stutterer and a newcomer to the language would speak very slowly the students would pay greater attention to what was being said. I hope I can continue to be an effective teacher."

These four — Bayne, Gordon, Lansford, and Lee, deemed by the college as the most outstanding — receive their very special award early in May when the award will take on a second significance. It was the decision of the committee to make the award itself a commemoration of the years of dedicated service to the college of its retiring dean, William L. Everitt. The teacher award is a bust of the Dean. Each of the four winners will receive a bust, and every winner in successive years will receive a bust. Decho — "It only seemed fitting that the man who contributed so much to the college should be honored in this way."

And this is just another move, another step, up a ladder toward excellence for the college of engineering. The teacher award is an innovation for progress. Progress, the credo of the engineer, is unstoppable. Another year, another step, toward the goal of the best education offerable. Another year, another step, until we shall all be like one working toward a mutual goal.

Edwin Black is a freshman English major. This is his fourth article for TECHNOGRAPH.



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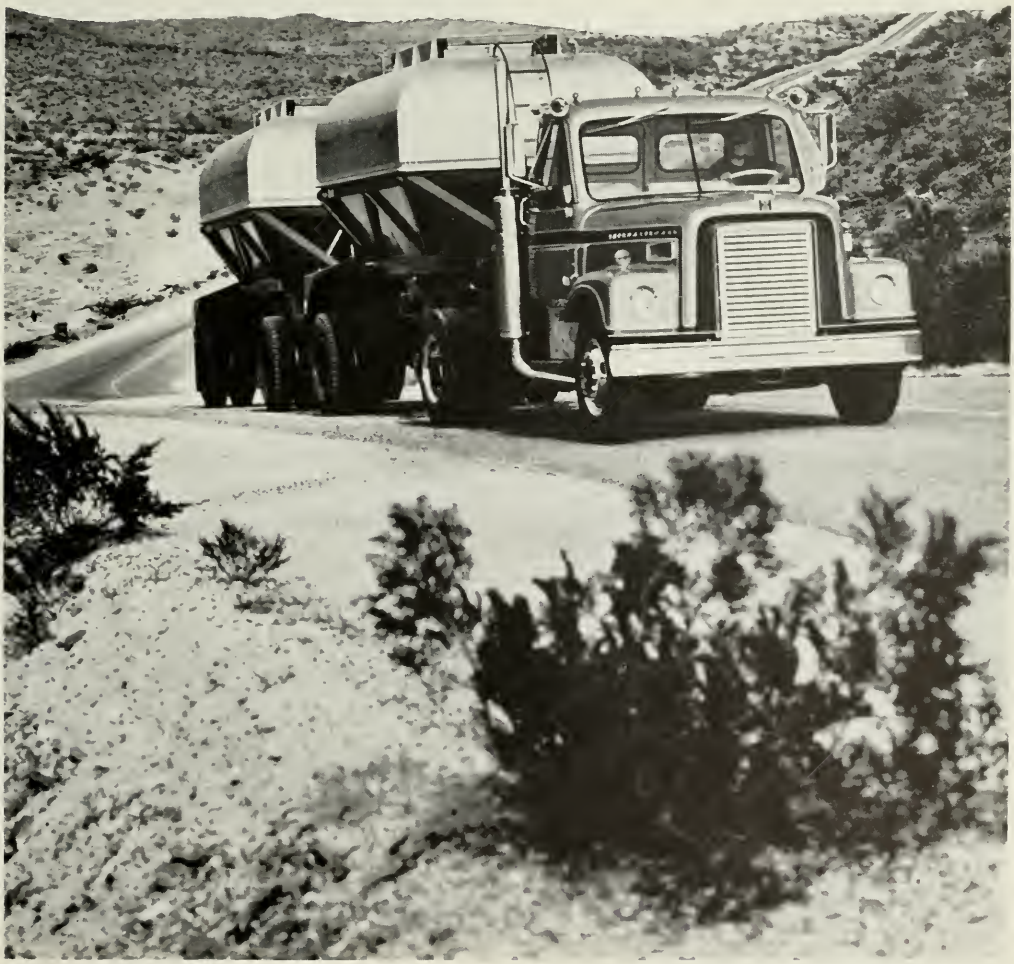

LIFE OR DEATH for engineering societies

"THE SPIRIT REINCARNATE"

by Donald E. Brewer
and Donald A. Hanson

The skeleton-headed creatures were staring through our faces. At any instant the police were ready to snap into action. However, the student branch of the Institute of Electrical and Electronics Engineers did successfully protect Commander John Hammack, Director of the Illinois Selective Service System, from a massive organized demonstration.

Indeed, this year's colorful and refreshing history of IEEE makes for a fascinating story. Yet from the exciting episodes we have learned some clues as to how an engineering society can further the professional development of its students.

Right from the beginning of the fall term, the student branch encouraged closer student-faculty relationships and strengthened student friendships by sponsoring a student-faculty picnic at Illini Grove. All participants deemed the picnic was a success except, perhaps, Marty-K, which failed to sell 600 sandwiches, and Professor Verdeyen, who broke his finger in a softball game.

As soon as the picnic was cleaned up, Chairman Don Brewer went to the drawing board to design a rather special award. The result was an inspiring plaque and an impressive image orthican, or television camera tube, which were enclosed in a plexiglass case on a walnut base. On October 21, 1967 this marvel was presented to Bob Hope. At the airport the student branch welcomed Hope to the campus and made him an honorary member of IEEE. Such recognition was justified because of the role electronic equipment and communication systems had played in his success.

Commander John Hammack was not quite as warmly welcomed at the University. Last November IEEE invited him to an open meeting at the Union to answer any questions about the, at that time, "new" draft laws. On the day of the meeting Don Brewer was called from a mathematics lecture to attend an urgent

Mr. and Mrs. Donald E. Brewer meet Bob Hope at the U. of I. airport.

meeting at the Chancellor's Office. The discussion centered around security measures to ensure an orderly meeting and the University's jurisdiction in controlling and disciplining students who might disrupt the program. Concern was for the rights of the demonstrators. That evening when Commander Hammack rose to speak, so rose forty skull-painted, black-hooded, ugly creatures. They intended to maneuver a flag-draped coffin into the meeting but were thwarted by Dean Wakeland, who indiciated to security officers that the coffin was *not* part of the program.

Believe it or not!

Two weeks later Dean Everitt spoke about "Men Who Play God" to get IEEE back to its normal, high-quality meetings. Following his presentaton Don Hanson awarded him an IEEE custom-built electronic crystal ball for his contributions to engineering students and electrical engineering. The crystal ball communicates via flickering neon blubs driven by interacting *relaxation* oscillators. By rubbing the surface of the crystal, one can influence the light patterns which are being transmitted. A potentiometer on the back of the walnut base controls the pattern repetition rate to allow the viewer to "tune in." The concept of interacting relaxation oscillators was developed by Dr. Babcock of the Biological Computer Laboratory.

Perhaps the most enjoyable activity for everyone involved was the senior-faculty banquet organized by Chuck Smiley. The students and faculty interchanged roles to produce the skit, "The Process of Synthysizing an Electrical Engineer" or "The Electric Field of Study". Mocking the student who burned his draft card at the Hammack meeting, Dean Everitt, disguised in a long, curly, flamboyant red toupee, protested the change of the units of cycles per second to Hertz by burning his IEEE card. Following the skit Dean Everitt advised engineers to be wary of marriage by performing his piano and song routine of "The Bald-Headed End of a Broom".

Through these entertaining activities IEEE established its unique character as a progressive student society. However, the real task of IEEE was to communicate its character and enthusiasm to its members. The challenge was met with four humorous newsletters, much publicity, and a complete record of society activities on slides. Imagine eternally capturing Dean Everitt standing on his head at the senior-faculty banquet to prove that not all engineers wear white socks. If a picture is worth a thousand words, IEEE has quite a windy argument for attending the National Electronics Convention held annually in Chicago. The demonstrations and lectures held there help the student perceive the state of his art. Thus, our activities were a vehicle to encourage student interest and participation in his professional society.

The societies offer a tremendous opportunity for students to informally discuss their interests, problems, educational development, and career objectives with experienced faculty and guest speakers. Hence, IEEE invites and introduces a number of faculty at each of its meetings. If student societies are to be of any value, they must provide a "coupling" between the student, his engineering department, and the real world.

Concluding the senior-faculty banquet, Professor von Foerster asked the question, "Where do we go from here: Up or Down? Up or down has deep religious implications. Right or left has nasty political connotations. Backward is unforgivable. Ergo, we must go *FORWARD!* Student societies, *move!*

The IEEE officers show off the marvel they presented to Bob Hope. From left to right are George Elmos, Don Hanson, Jim Simpson, Joe Dale, Don Brewer, Prof. Egbert, Art Feinberg, and Jack Hammond.

"The excitement in engineering doesn't all happen in a development lab."

"I found that out when I started selling computers.

"Obviously, they're expensive. Nobody's going to buy one unless I can show him why it'll be worth the investment. (This is Bob Shearman, Mechanical Engineer, an IBM Medical Representative in Marketing.)

"My customers happen to be doctors and scientists. Naturally, I have to find out what their problems are before I can hope to build a case for installing a computer. That's what I find exciting. This whole process of helping somebody solve a knotty problem.

"For example, one of my installations is at a cancer research institute. A problem came up when they decided to build a radio therapy suite about a block away from the computer. The doctors wanted to communicate with the computer right from a patient's bedside.

"The general solution was easy enough. We knew we'd have to use some sort of remote terminal. But from then on it was a process of exploration. I asked a lot of questions, dug up a lot of facts, and generally helped the customer arrive at a detailed definition of his problem. Then I worked closely with IBM and the customer until we had the right terminals installed and functioning.

"In a job like this, you use your engineering background all the time. Whether you're defining a problem or showing the customer how our equipment can help solve it."

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USAF SRAM. New U.S. Air Force short-range attack missile, now being designed and developed by Boeing, is a supersonic air-to-ground missile with nuclear capability. Boeing also will serve as system integration and test contractor.

NASA Apollo / Saturn V. America's moon rocket will carry three astronauts to the moon and return them to earth. Boeing builds 7.5 million-pound-thrust first stage booster, supports NASA in other phases of the program.

Boeing 747. New superjet (model shown above) is the largest airplane ever designed for commercial service. It will carry more than 350 passengers at faster speeds than today's jetliners, ushering in a new era in jet transportation.

NASA Lunar Orbiter. Designed and built by Boeing, the Lunar Orbiter was the first U.S. spacecraft to orbit the moon, to photograph earth from the moon and to photograph the far side of the moon. All five Orbiter launches resulted in successful missions.

Boeing 737. Newest and smallest Boeing jetliner, the 737 is the world's most advanced short-range jet. It will cruise at 580 mph, and operate quietly and efficiently from close-in airports of smaller communities.

USN Hydrofoil Gunboat "Tucumcari". Designed and being built by Boeing, this seacraft will be first of its kind for U.S. Navy. Powered by water jet, it is capable of speeds in excess of 40 knots. Other features include drooped or anhedral foils, designed for high speed turns.

U.S. Supersonic Transport. Boeing has won the design competition for America's supersonic transport. The Boeing design features a variable-sweep wing, titanium structure and other new concepts and innovations.

CH-47C Chinook Helicopter. Boeing's newest U.S. Army helicopter is in flight test at Vertol Division near Philadelphia. Other Boeing/Vertol helicopters are serving with U.S. Army, Navy and Marine Corps.

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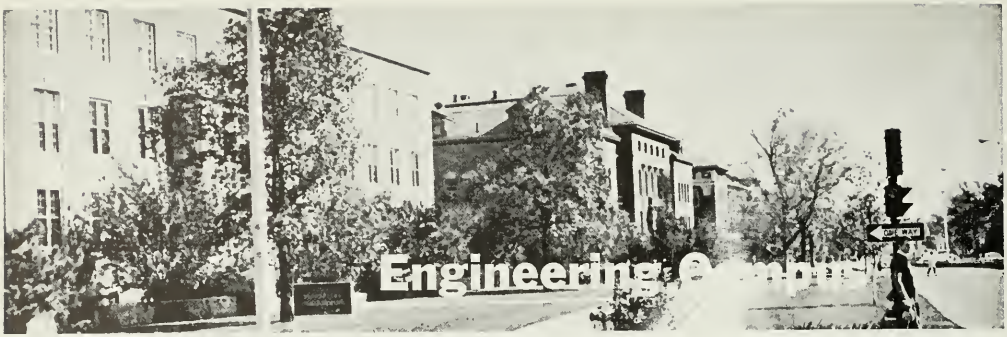


UNIVERSITY OF ILLINOIS GETS PERPETUAL MOTION MACHINE

by Dick Poynter

A perpetual motion machine is a machine which, after initially being put into motion, will continue forever to remain in motion without any external force acting upon it. Down through the centuries countless scientists and physicists have tried to create one of these fantastic machines that won't stop running.

The U of I has a device which may be the closest thing yet to being a perpetual motion machine. It is a superconductor. A superconductor is made by supercooling a metal rod almost to absolute zero (about 419° F.). As the temperature of a pure metal rod approaches absolute zero, its electrical resistance decreases. It will finally reach a point where the resistance is so close to zero that an electric current passes through it with no detectable loss; the current flows indefinitely in a closed circuit. A circuit such as this has had exactly the same current in it for the past twenty years in a University of Illinois lab, and there is no reason to think that it will not continue.

Research concerning superconductors is being conducted in a lab in the basement of the Materials Research Laboratory. I visited this lab and watched a sample of metal being tested. Two experimenters, Jon Carlson and Dan Gutman, explained their work. They were conducting tests on the thermal conductivity of Niebium. The basis of these experiments was founded in 1957 when Professor Bardeen of the University and two graduate student assistants formulated a theory of superconductivity on the basis of atomic physics. This theory was better than previous theories in that it predicted temperature and magnetic field dependence of thermal conductivity. Carlson and Gutmar are testing this theory by measuring the thermal conductivity to see if the sample does have the predicted dependence.

A pure sample of Niobium is used when checking the theory. The purer the sample the less resistance at low temperatures. Resistance of the sample at room temperature was determined by putting the sample in a complicated circuit of voltmeters, ammeters, and potentiometers. The Niobium sample must be cooled to a temperature below 9.25° K. before it will assume superconductor qualities. This temperature is reached by using a cryostat, a device like two vacuum-type thermos bottles, one inside another. The larger has liquid nitrogen in it. The liquid nitrogen, which is at a temperature of 77° K., completely surrounds the smaller flask and acts as an insulator. The inner container is filled with liquid helium, at 4.2° K., cold enough to cool the sample to the desired temperature. The Niobium, on a stainless steel tube which has four wires attached to it so a current can be sent through it and voltage across it measured, is then placed in the liquid helium, and subjected to an electric current. If no resistance is detected, then it is suitable as a superconductor.

There are several practical uses for superconductors. They could become an important part of computer circuits. Certain components with no resistance at all would be invaluable. Superconductors would make excellent permanent magnets, because they are very economical. Transmission of electrical power from coast to coast would be possible through superconducting wires which are properly insulated.

There is no limit to the uses for a superconductor. Perhaps one will be developed into a perpetual motion machine. The only answer is to continue the research of superconductors.

ASTRONOMY DEPARTMENT GETTING NEW EAR AND EYE

By Mike Feldman

At the present time the Astronomy Department has only one observation facility — the 400 foot radio-telescope near Danville. This is a transit instrument; its reflector is built into the ground and it can only be focused in a north-south direction. To be observed, a given source must be overhead, and it must be fairly high above the north or south horizon. This telescope is being used to map radio sources by recording signals as the earth turns.

Above is an artist's conception of the 120 foot radio-telescope under construction near Danville.

To supplement the 400 foot telescope, a 120 foot steerable dish is now under construction. Although this telescope is less sensitive and has poorer resolution than the 400 foot telescope, it is much more versatile. It can be brought up to bear quickly on most parts of the sky, it can track an object across the sky for long periods of time, and the listening frequency can be easily changed. The telescope is not only steerable but will be mounted on tracks so that its distance from the 400 foot telescope can be varied and the two can be used as an interferometer. This usage gives much better resolution and positional data, and correlation of data can eliminate signal irregularities due to inherent idiosyncrasies in the particular antenna. The 120 foot telescope will be used primarily to confirm data from the 400 foot telescope, but its mobility and versatility enable it to be used for small projects and to react quickly to new discoveries.

Optically, research observation for the department must be done by outside observatories. Most observation will be taken over by a 40-inch reflector now being built by a firm in Texas. The observatory, which is partially completed, is located 40 miles south of Urbana near Oakland, Illinois. The telescope will be used mostly for spectroscopic work, and it will be used for some direct photography and photo-electric intensity analysis. The research schedule for the observatory is already filled far into the future.

Construction on the Oakland Observatory will be done in a few months and the telescope will be delivered in July. Work on the radio telescope will continue through the summer, and it is expected to be completed late next fall. The work is contracted by an engineering firm, but much of it is to be done with student help.

G. E. DEPARTMENT SUCCESSFUL IN DEVELOPING INTEGRATED DESIGN SEQUENCE

by John Barra

Over a year and a half ago, the General Engineering Department at the University of Illinois initiated an educational program with an integrated design sequence in order to update the curriculum with respect to the needs of the General Engineering students and the employing industries. A four-step program was begun in September of 1966 with the aid of a three-year Ford Foundation Grant totaling $120,000. Now, after one year in operation, this program has just undergone a review by the General Engineering Department and has been termed a huge success.

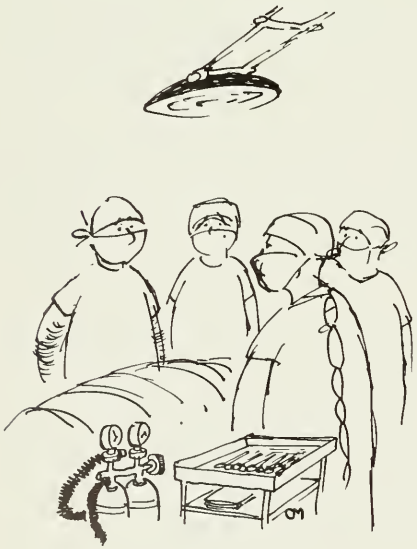
The first of four parts in this overall program is an attempt to better perpetuate the College of Engineering, especially the General Engineering Department. One of the major weaknesses of the engineering curricula has been that engineering students have had no vehicle for identification and motivation in engineering at the freshmen level. No courses were offered which allowed freshmen to experience any involvement in actual engineering practices. Hence, many students became discouraged, resulting in a large transfer rate out of the College of Engineering.

The General Engineering Department, in the first step of their updating program, therefore introduced a freshmen level design course, G.E. 104 — the first of the seven courses in the sequence. This course proved to be a great success in its first year. Not only were the freshmen general engineers exposed to engineering design, but also a selected number were allowed to actually participate as assistants in senior project designs. These freshmen gained both valuable experience and a stronger motivation while proving to be of great value to the senior engineers.

Another major facet of the program is to have a number of the general engineering professors prepare case studies and supplemental notes which would be of practical value in the seven design courses. In order for this to be done, however, released, paid time had to be given to the professors so that they could work on these studies and notes. The Ford Grant offered the monetary aid to provide this released time.

The third part of the program deals with the relationship between the engineering college and the industries. Staff member aid provided travel funds via the Ford Grant to visit various industries in an attempt to gather information to prepare the case studies for the design courses. These visits allowed the General Engineering Department to better coordinate its design courses according to the needs and patterns of industries which might employ general engineering students.

The final portion of the program under the Ford Foundation Grant is financing design engineers from various industries to come to the University to work directly with the staff and students in preparing design projects and studies. The design engineers brought various design problems from their companies for senior students to study. In this way a service was provided for the staff, students, and the industries, strengthening the ties between each other.



"You won't believe this Ed, but this guy's been stabbed with a slide-rule."

The seven courses of the design sequence range from graphics and analysis to component and project design. This sequence, stressing the interdisciplinary aspects of engineering design, gives consideration to all scientific, economic, and engineering factors. In the organization of the design sequence, much attention has been given to the needs of both the students and the industries.

The significance of this is that the integrated design sequence produced will better prepare the general engineer for his future, whether in engineering design or any other secondary field he chooses. Through this program, the relationship between the General Engineering Department and industry has been strenthened, both gaining a better insight into each other's needs. The fact that the Ford Foundation offered $120,000 to finance this program indicates industry's growing interest in programs of this nature.

NEW ANTENNAS FOR SPACE & DEFENSE

by Alan Bettner

America's increased use of the radio spectrum has resulted in sudden demands for special types of radio antennas. Engineers at the University of Illinois Antenna Research Laboratory are designing several types of antennas for use on space vehicles, guided missiles, and commercial communications equipment.

In designing a particular antenna, the engineer has four factors of prime importance to consider:

1. Beamwidth, or the amount of radiation an antenna will throw in a given direction. The narrower the beamwidth, the higher the gain in a certain direction.

2. Bandwidth, which is the range of frequencies for which the antenna is capable of operating efficiently.

3. Polarization, the direction of the electric field in the plane perpendicular to the direction of wave travel.

4. Compactness and weight.

It is physically impossible to have all of these factors ideal in one antenna, but it is possible to maximize two or more to full advantage. This is the goal of the men at the laboratory.

Professor P. E. Mayes recently supervised over the designing of a flush mounting frequency independent antenna for use on aircraft and missiles. Where streamlining is necessary, this is an ideal antenna because none of it protrudes outward.

The antenna itself is a series of slots cut into sheet metal, each of which resonates at a different frequency. However because radiation is produced both below

and above the slots, a way to force all the radiation away from the vehicle was needed. This was accomplished by placing below each slot a metal cavity of special dimensions. As the signal attempts to radiate inward, it is reflected by the cavity and travels outward from the traveling aircraft. Although this method greatly increases the efficiency of the antenna, it is still not considered to be highly directive.

The next type of antenna being constructed is a series of high gain helical dipoles. The theoretical research on this antenna is being done by Fred Ziolkowski, a graduate student.

According to Ziolkowski, the major advantage of this array is its small size and high gain. Narrow beamwidth is achieved by using two, 3/2 wavelength dipoles placed a few feet apart. The antenna now resembles the common Yagi television antenna but possesses two elements rather than a dozen or more. To decrease the length of the individual dipoles, the wire is wound into a spiral helix which is only about five feet long. The antenna not only has high gain, but excellent portability.

Practical uses for this antenna are numerous. Helical mobile antennas are already available commercially. The helix array also has outer space applications such as satellite tracking or low power communication.

A third type of antenna is perhaps the most interesting to look at because it is shaped like a huge ice-cream cone. Intense work on this conical antenna has been done by Prof. J. D. Dyson. Dyson began with the study of the wave pattern emitted from a spiral shaped wire in a single plane. The bandwidth of the spiral was very good, but its directivity was poor. However, when the spiral was wrapped around a cone, the wave pattern suddenly shifted into the direction the cone pointed! Here was an antenna with good gain and extremely large bandwidth.

The polarization of conical radiator is very unique, for the electric field rotates in the direction of spiral at the frequency of the input signal. (On a regular antenna the polarization remains constant.) To receive this rotated signal well, another cone with the same direction of spiral is needed. This may seem like a disadvantage, but it has several possibilities in discriminatory wave detecting systems. With improvement we may be able to produce a radar system which will not be disturbed by rain or snow, but will respond to an enemy aircraft.

All of the antennas being designed at the Antenna Research Laboratory have valuable future applications. With the growing use of the U.H.F. regions of the radio spectrum for defense and outer space exploration, these new antennas offer great possibilities for communication on bands never before used.

Research opportunities in highway engineering

The Asphalt Institute suggests projects in five vital areas

Phenomenal advances in roadbuilding techniques during the past decade have made it clear that continued highway research is essential.

Here are five important areas of highway design and construction that America's roadbuilders need to know more about:

1. Rational pavement thickness design and materials evaluation. Research is needed in areas of Asphalt rheology, behavior mechanisms of individual and combined layers of the pavement structure, stage construction and pavement strengthening by Asphalt overlays.

Traffic evaluation, essential for thickness design, requires improved procedures for predicting future amounts and loads.

Evaluation of climatic effects on the performance of the pavement structure also is an important area for research.

2. Materials specifications and construction quality-control. Needed are more scientific methods of writing specifications, particularly acceptance and rejection criteria. Additionally, faster methods for quality-control tests at construction sites are needed.

3. Drainage of pavement structures. More should be known about the need for sub-surface drainage of Asphalt pavement structures. Limited information indicates that untreated granular bases often accumulate moisture rather than facilitate drainage. Also, indications are that Full-Depth Asphalt bases resting directly on impermeable subgrades may not require sub-surface drainage.

4. Compaction of pavements, conventional lifts and thicker lifts. The recent use of much thicker lifts in Asphalt pavement construction suggests the need for new studies to develop and refine rapid techniques for measuring compaction and layer thickness.

5. Conservation and beneficiation of aggregates. More study is needed on beneficiation of lower-quality base-course aggregates by mixing them with Asphalt.

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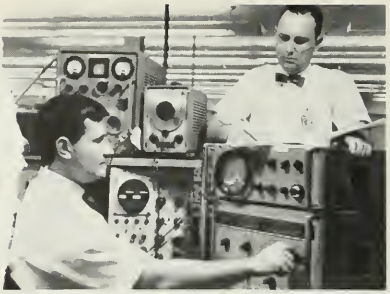

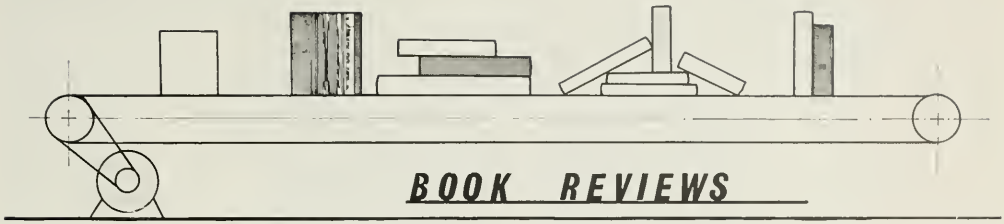

BOOK REVIEWS

A Descriptive Inventory of the Arts and Sciences

By Joseph T. Tykociner, 1967; reviewed by Alan Halpern

During the next generation, the store of man's knowledge will more than double, the world's population will be two and one-half its present size, and our generation will be called upon to solve some of the most complex problems to date. The "explosion of knowledge" and the implosion of our world make it singularly important that we systematically pursue and utilize knowledge in an effective and wise fashion. The difficulty and sophistication required for the search of an accurate model of Nature have produced the specialist and with this trend has come a foreboding threat.

One of the earliest to foresee the dangers of specialization was Professor Joseph Tykociner, now an Emeritus Professor in Electrical Engineering. As he recalls, "On a leave of absence during my sabbatical year (1927-28), I found myself deeply concerned with certain fundamental ideas that might serve as a basis for creativity in general and for research in particular... As the conception of a systematized knowledge of research crystallized in my mind, the need arose for a unified system of knowledge embracing all the branches and subdivisions of the arts and sciences."

The science of Zetetics was formulated to "develop a generalized, comprehensive view (so that)... man will be in a better position to appreciate the necessity for growth in the various arts and sciences and to evaluate their roles in shaping the future. The goal of Zetetics is to provide an overview, an index to the interrelationships of knowledge. It is to observe and define that, as one poet has written: Thou canst not disturb a flower without troubling a distant star. The Zeteticist is a generalist, one prepared to consider the "spin-off" and the social impact of technical discoveries.

In his previous book, *An Outline of Zetetics*, Professor Tykociner sets forth a description and general philosophy of the system. In this subsequent volume, he provides the structure necessary to "facilitate the search for interrelationships among the various fields of knowledge, revealing gaps and then suggesting new problems for research." The book consists of lists of the subdivisions of knowledge which are functionally defined and logically interrelated. There are 1500 items, each accompanied by a brief, identifying description and a denotion of other areas which will be affected by developments in this field.

Our age requires that we approach and solve problems fully cognizant of the implications for other portions of our lives. The automobile may solve the transportation issue, but it has polluted the air, and because of lack of foresight in the big cities, it has not even adequately solved that problem. Engineers are particularly susceptible to purblind specialization. In the past, the great frontier has allowed inefficiency and myopia, but we are living with the polluted air, and water, the congested highways, the depleted forests and ugly urban sprawl which are the results.

The Zetetic system offers a philosophy, an absolute approach to the fundamental framework for the expansion of knowledge and the building of a cohesive society. The system, however, does not nor can it explicitly presage which gaps should be explored first. By pointing out gaps in our knowledge, the system identifies, within the realm of knowledge, areas which have been overlooked, but no indication is given for the direction of that "one step beyond." Presently, using system analysis, however, the Zetetic approach is being incorporated into our thinking and our planning. The ever-increasing influence which technology exerts on society makes it mandatory that engineers look carefully beyond the lab.

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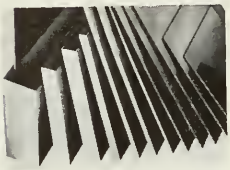

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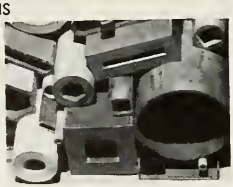

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To The Editor:

I have just recently become acquainted with the student rating system currently employed by the College of Engineering. I am appalled that a college of such distinction would employ such an insult to modern education. The current rating form, system and substance could only have been prepared by engineers for use by engineers. I personally would be ashamed to let a reasonably intelligent social socientist see the criteria of the judgment form or anything else connected with the system.

The present system, described to students in the last issue of TECHNOGRAPH (Editorial, March, 1968), gives an indication of the subjectiveness of the judgments forced on instructors. There is space on the rating form for the statement of no opinion but the form would not be distributed without the expectation of a judgment. It is no wonder that the rating system — supposedly not played down by the college — is not listed among the University's student services.

The material compiled by the ratings, a copy of which is given to graduating seniors, is presented to any company interviewing the student and requesting the information. It is also true that the system sees very limited use. The question remains: Does the limited use of such a facility warrant its existence in the face of its many and obvious faults?

If the system sees sufficient use to warrant its existence, let it remain as a service to interviewing companies, but let it change its scope, format, and procedures. If it sees such limited use that the cost of its existence is not really warranted, let interviewing companies be provided with a list of faculty members who have instructed a particular student and let this present travesty disappear. The administration of the College of Engineering has been remarkably silent regarding details of the system and its operation. If justification of a system does exist, it should be articulated, but justification of the present system is and must be lacking.

There is a student committee studying possible alternatives to the present system. They have already accumulated considerable information in addition to the opinions of professionals in the fields of testing, counseling and the evaluation of students. Let this committee propose a solution, but also let its existence enjoin the College of Engineering to suspend its present system and hold its records from release.

Respectfully submitted,
Charles H. Ludmer

To The Reader:

Saturday, March 16, a group concerned with engineering education met in the Faculty Lounge of the Union. The group, informally calling itself the Ad Hoc Committee on Engineering Education Reform, was composed mainly of students, with some graduate assistants, faculty, and administrators. After about a three-hour bull session, the group broke up with few if any concrete proposals.

So why report on another of the never-ending bull sessions which led to nothing? Well, the fact is this bull session did lead to something, for since March 16 several meetings of a smaller group of students have taken place. Now this smaller group is starting to study specific problems of engineering education at Illinois. By the time this letter is published, hopefully most of you will have had the right to comment about some of the group's immediate proposals.

The long-range plans of this committee are to research several areas of engineering education from a student point of view. Then, after these investigations are complete, specific proposals will be developed. How many engineering students have had questions answered with an unsubstantiated "No"? How many engineering students feel that their education is encouraging them only to be good technicians? How many engineering students feel their education encourages them to identify problems and their parameters as well as simply solving problems when all the parameters are given?

All these questions are pertinent for they have an effect on the future of the engineering profession. They deserve some of your thought and some of your action.

Orin Ireland

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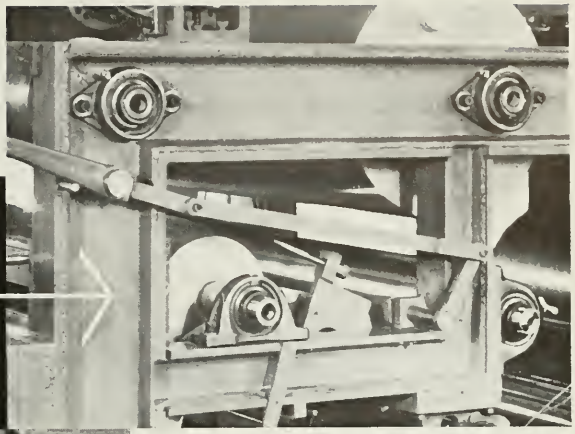

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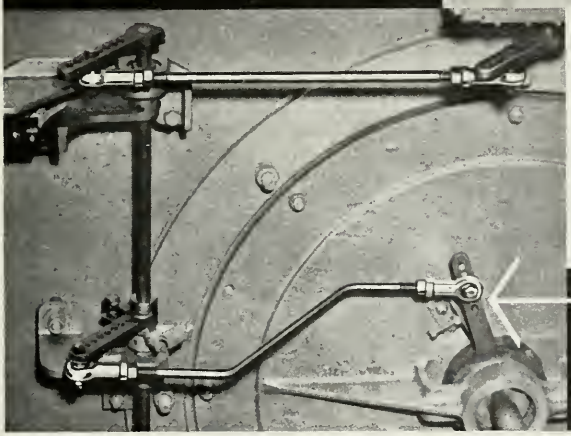

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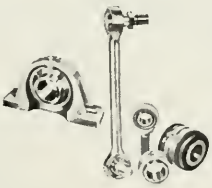

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FUTURES

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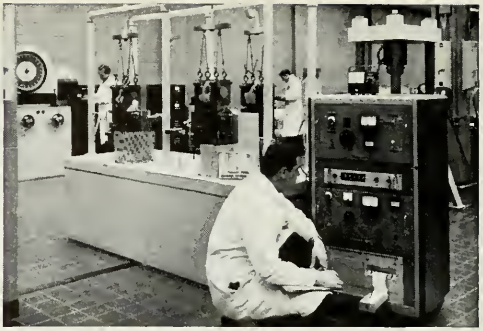

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Dan Johnson has a flair for making things.

Just ask a certain family in Marrakeck, Morocco.

A solar cooker he helped develop is now making life a little easier for them—in an area where electricity is practically unheard of.

The project was part of Dan's work with VITA (Volunteers for International Technical Assistance) which he helped found.

Dan's ideas have not always been so practical. Like the candlepowered boat he built at age 10.

But when Dan graduated as an electrical engineer from Cornell in 1955, it wasn't the future of candlepowered boats that brought him to General Electric. It was the variety of opportunity. He saw opportunities in more than 130 "small businesses" that make up General Electric. Together they make more than 200,000 different products.

At GE, Dan is working on the design for a remote control system for gas turbine powerplants. Some day it may enable his Moroccan friends to scrap their solar cooker.

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